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Mollusca, Solenogastres

The aplacophoran molluscs are represented in the fauna associated with the hydrothermal vent biotope by the Solenogastres (neomeniomorphs); members of the second class Caudofoveata (chaetodermomorphs) have not yet been evidenced. Solenogastres show a narrowed body, glide upon their restricted foot (pedal groove), and are carnivorous. They include about 245 known species. However, neither these nor the presently three described species from the hot vent areas documented here reflect the true biodiversity. Several new species under description and additional representatives come from the East Pacific Rise 13°N (Genesis, Parigo, Elsa), 9°N (Tica), 18°S, and 21°S; and the Mid-Atlantic Ridge, Rainbow.

Recorded hot vent Solenogastres range between 1.5-6 mm length and are – characteristically for all aplacophoran molluscs – covered by small aragonitic sclerites. Because these sclerites are important specific as well as supraspecific characters, the collected animals should be preserved in 70% ethanol (or in formalin and soon transferred to ethanol) to save the sclerites for determination. Furthermore, specimens should be preserved as soon as possible after sampling, because internal organs (as important as the sclerites) rapidly undergo histolysis (as was the case in quite a number of specimens from the above records).

1: *Helicoradomenia* sp. 2 from southern East Pacific Rise: 21°S; cruise Biospeedo © Ifremer.

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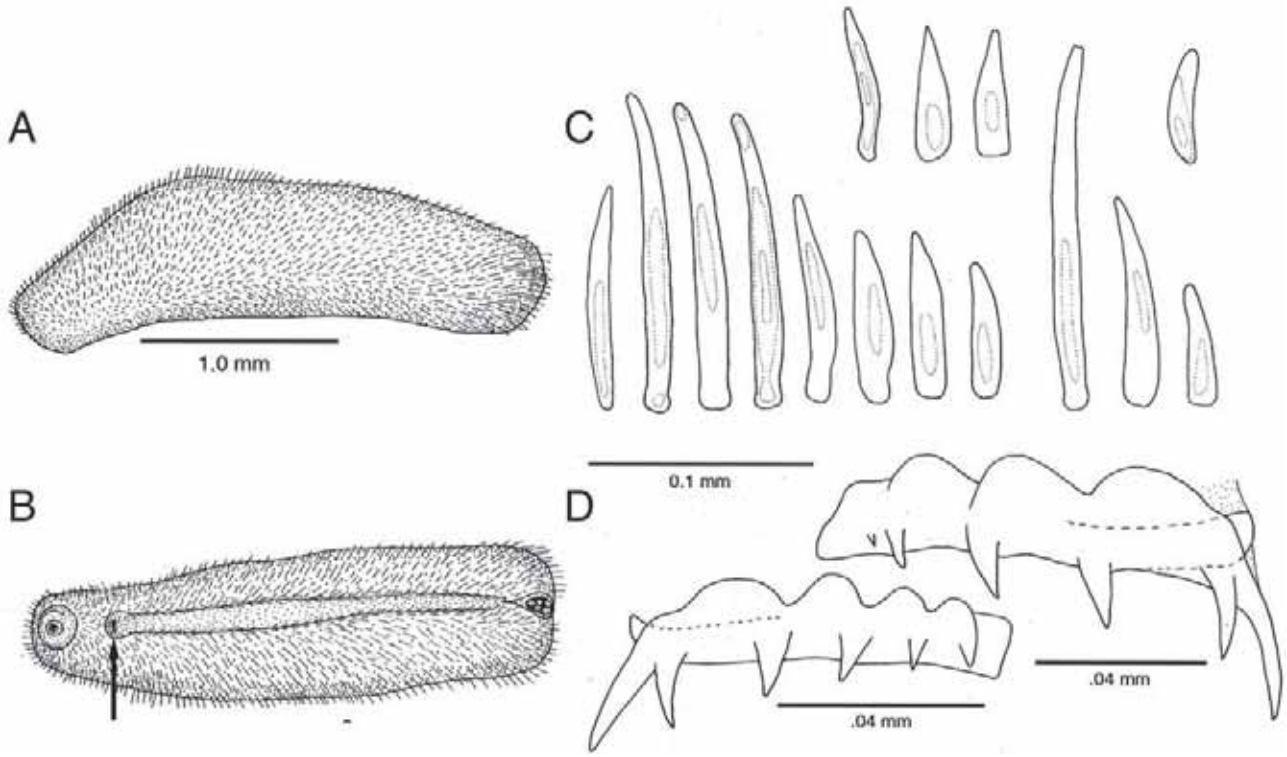
Helicoradomenia acredema SCHELTEMA, 2000

Size: Up to 3 mm.

Morphology: Solenogastres of cylindric body somewhat tapering at both ends, posterior end bluntly rounded and somewhat flattened dorsoventrally; appearance similar to *H. juani*, but shorter and fuzzier. Dominant sclerites slender and up to 190 µm long with distal end rounded, in part with distal swelling; dorsofrontal sensory pit often obvious as transverse slit. Radula in sheath distinctly bipartite, paired ventral radula sack at end curved; radula plates with 5-7 denticles, the lateral-most distinctly longer and close to next one. Paired copulatory stylet apparatus with two elements each.

Remarks: There is no information concerning the internal soft organs. Due to the similarities or even possible identities of hard parts in different species (two new species are under description), the conspecifity of specimens far off the type locality (see distribution) needs to be confirmed according to internal organisation. See also *H. juani*.

Distribution: East Pacific Rise: 21°N (type locality), 17°24'S; Galapagos Spreading Center.



1A, B: Holotype in lateral (A) and ventral (B) views (anterior end at left); arrow points to pedal pit; C: Mantle sclerites; main type elongate and often with distal swelling; D: Two radula plates in dorso-frontal view, above from a right row, below from a left row; after SCHELTEMA (2000).

References:

SCHELTEMA A.H. (2000) Argonauta **XIV**(2): 15-25.

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Helicoradomenia bisquama SCHELTEMA, 2000

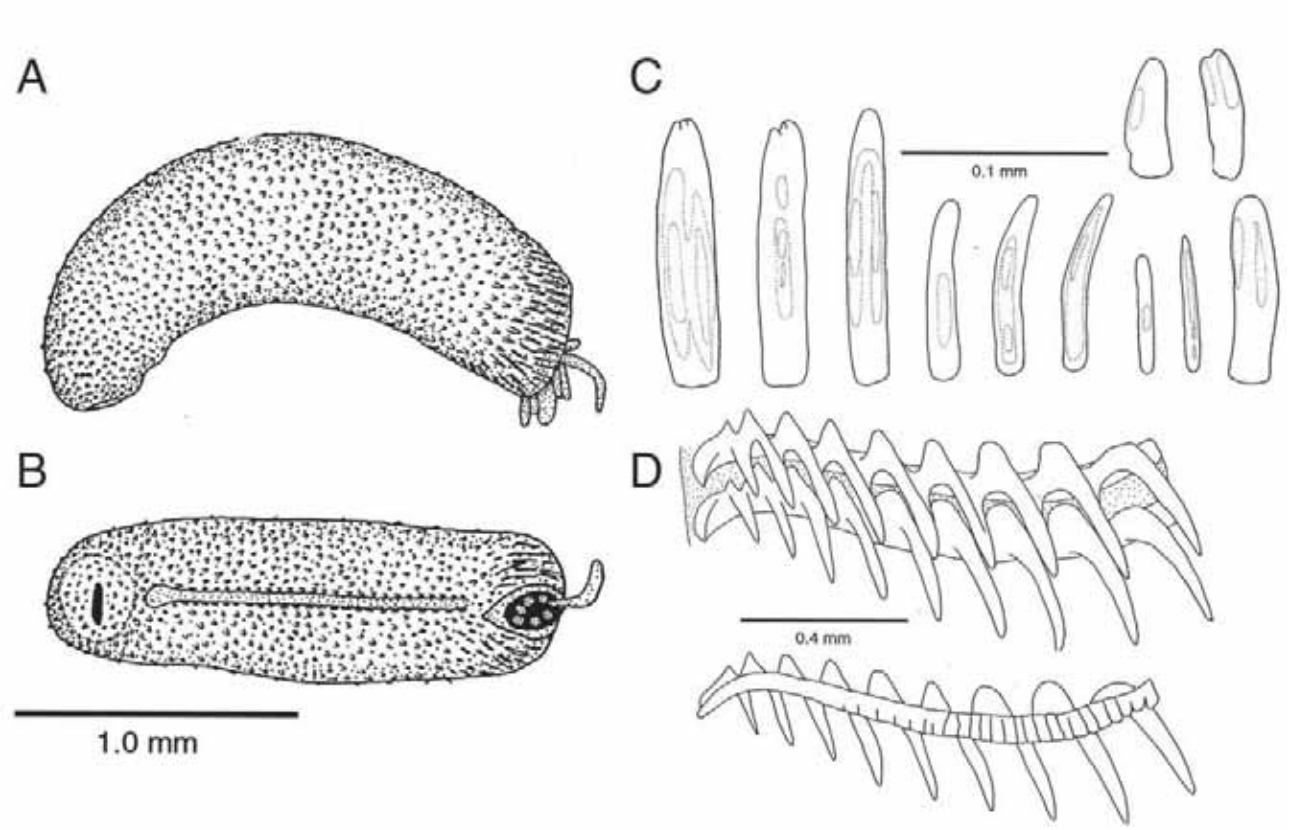
Size: Up to 3.5 mm.

Morphology: Solenogastres of cylindric body slightly tapering at anterior end, posterior end truncate, appearance rough and bumpy. Sclerites up to 135 µm long, most of which broad and thickest at margins as if formed of two joined spicules, often with bifurcate distal end. Dorsofrontal sensory pit not obvious. Radula biserial with paired ventral sack, at end spirally enrolled; radula plates with nine denticles with increasing length towards lateral. Paired copulatory stylet apparatus with seven (3+3+1) elements each.

Remarks: Though there is poor information concerning the internal soft organs, the present species is within *Helicoradomenia* (see *H. juani*) well-defined by the characters of the hard parts.

Biology: From vent clam (*Calyptogena*) or vestimentiferan (*Riftia*) beds.

Distribution: East Pacific Rise: 21°N.



1A, B: Holotype in lateral (A) and ventral view (B, anterior end at left) with part of respiratory papillae protruding from mantle cavity; C: Mantle sclerites; D: Three radula plates of a right row: two plates (above) upon radular membrane (stippled) in dorsofrontal view, one plate (below) in ventro-abfrontal view showing basal bar with serrations; after SCHELTEMA (2000).

References:

SCHELTEMA A.H. (2000) Argonauta **XIV**(2): 15-25.

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Helicoradomenia juani Scheltema & Kuzirian, 1991

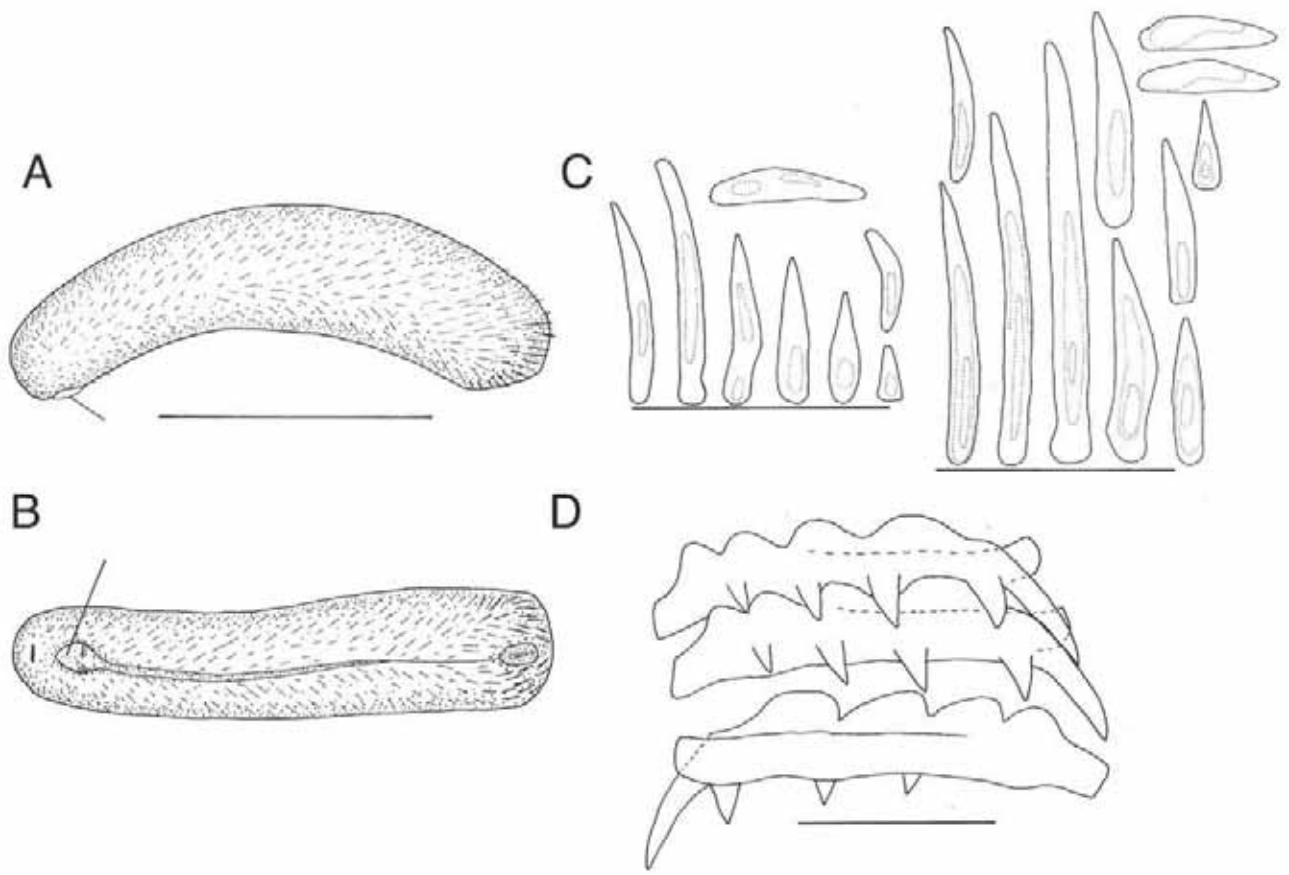
Size: Up to 5 mm.

Morphology: Solenogastres of cylindric body somewhat enlarging posteriorly, anterior end rounded, posterior end somewhat flattened ventroterminally; appearance fuzzy due to one layer of solid, elongate, slightly curved sclerites, distally with blunt point, and measuring posteriorly up to 200 µm in length. Dorsofrontal sensory pit obvious as transverse slit. Radula biserial with paired ventral sack, at end spirally enrolled; radula plates with 5-6 denticles, the lateral-most distinctly longer and close to next one. Mouth opening within posterior atrium/vestibulum; with multicellular dorsal foregut gland and with short esophagus; one pair of shortly stalked seminal receptacle. Paired copulatory stylet apparatus with two elements each.

Remarks: *Helicoradomenia* is particularly defined by a biserial radula with paired ventral sack, by solid, elongate sclerites in one layer and by a dorsofrontal sensory pit. Specific characters refer to detailed shape of hard parts (sclerites, radula plates, copulatory stylets) as well as to soft internal organs (configuration of foregut, of accessory genital organs and of pallial cavity). There are other hydrothermal vent representatives under description belonging to *Helicoradomenia* and to different genera (see Fig. 2-7).

Biology: Carnivorous, but probably not on Cnidaria.

Distribution: Juan de Fuca Ridge: Endeavour Segment; Explorer Ridge; Gorda Ridge.



1A, B: Holotype in lateral (A) and ventral views (B, anterior end at left); line points to pedal pit; scale bar 2 mm; C: Mantle sclerites of anterior (left) and posterior body (right); scale bar 0.1 mm; D: Three radula plates: two plates (above) of the right row in dorso-frontal view, one plate (below) of the left row in ventro-abfrontal view; scale bar 0.5 mm; after Scheltema & Kuzirian (1991).

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2: *H.* cf. *acredema*, in vivo specimen from East Pacific Rise: 9°N, site Tica; by M. Bright.

3: *Helicoradomenia sp*. 1, in vivo specimen from East Pacific Rise: 9°N, site Tica; by M. Bright.

4: *Helicoradomenia sp*. 2, body length 2 mm, in ventral view, anterior end at left showing slit-like dorsofrontal sensory pit and atrio-buccal area, pedal groove (foot) wide; from East Pacific Rise: 18°S; cruise Biospeedo © Ifremer.

5: Simrothiellidae gen. et sp. 1, body length 3 mm, lateral view, anterior end at left; mantle in part with dorsal incrustation of orange iron oxide; from East Pacific Rise: 13°N, site PP Hot 3 (Elsa); cruise Phare © Ifremer.

6: *Helicoradomenia* sp. 3, body length 2.3 mm, lateral view (anterior at left), mantle with incrustation by yellow-orange deposits; from East Pacific Rise: 21°S; cruise Biospeedo © Ifremer.

7: Two specimens of Simrothiellidae sp. in vivo from North Fiji Back-Arc Basin, site White Lady; cruise TUIM06MV (June 2005, MBARI) © G. Rouse.

Reference:

Scheltema A.H. & A.M. Kuzirian (1991) Veliger **34**: 195-203.

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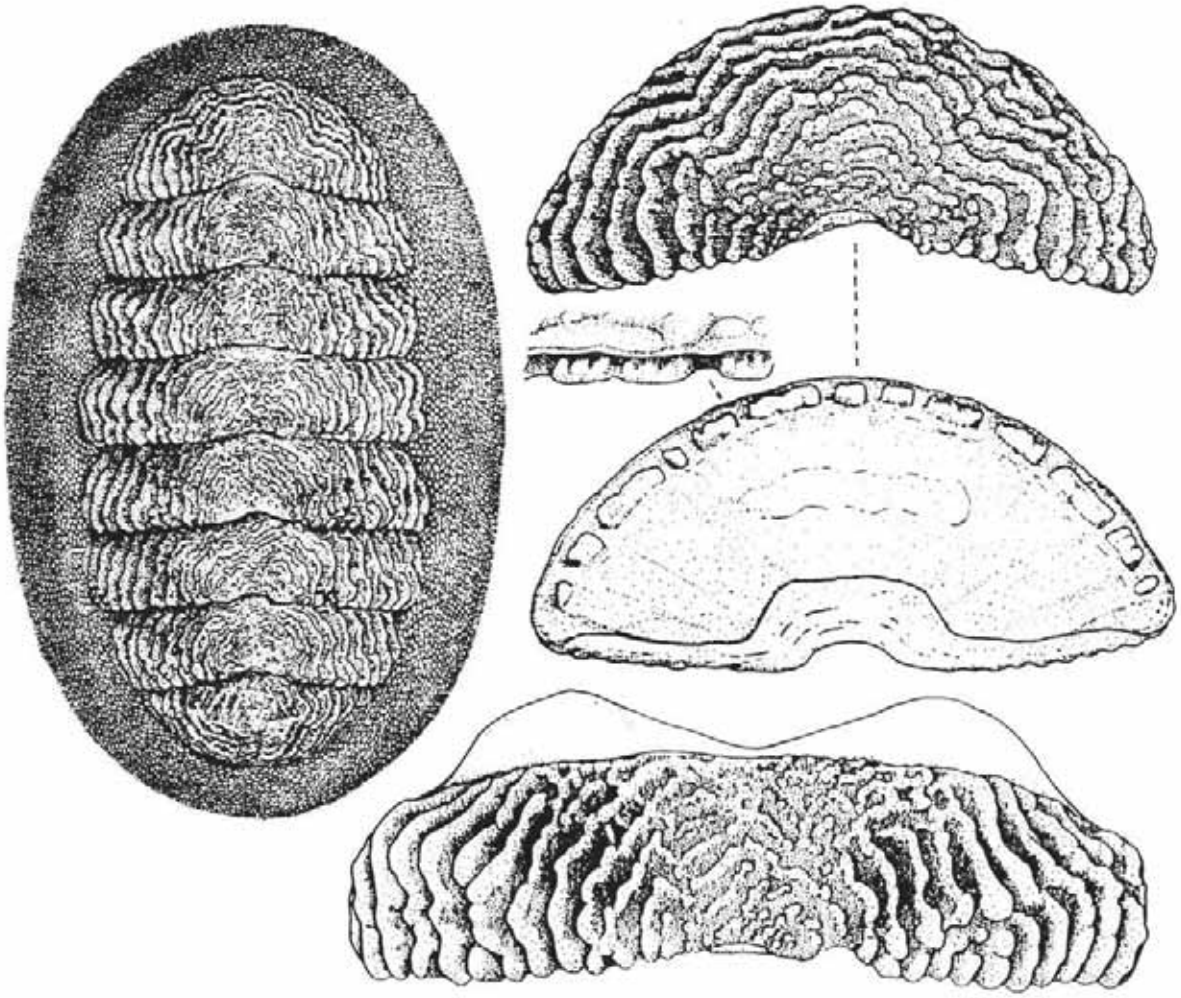
Thermochiton undocostatus Saito & Okutani, 1990

Size: Length up to 13 mm.

Morphology: Animal elliptical, little elevated, with a sub-carinated back. Girdle rather broad, with imbricating obliquely set, convex, finely ribbed scales, which possess a granular dorsal edge and with slender and smooth, marginal spiculae. Tegmentum (dorsally visible part of the valves) sculptured with somewhat irregular, concentrically arranged undulatin costae, strong towards the outer margins and weaker and more irregular near the apices. Articulamentum (layer beneath tegmentum) at the middle of the intermediate valves with a transverse callus, sutural laminae roughly triangular in intermediate valves, trapezoid in the tail valves. Valves and girdle white, exposed surface with rusty brown deposits. Radula ca. 4 mm long in the 13 mm specimen, with 170 densely packed teeth rows.

Biology: Found together with the other species *Lepidochiton tenuidontus* among bivalves *Bathymodiolus* and *Calyptogena*, siboglinid tubeworms and shrimps. It is not yet known whether the two species are endemic to vents or they also occur elsewhere.

Distribution: Okinawa Trough: Iheya Ridge.



1 left: Dorsal view; top right: Head valve, exterior and interior; bottom: Valve 4, anterior view; after Saito & Okutani (1990).

Reference:

Saito H. & T. Okutani (1990) Venus **49**(3): 165-179.

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Leptochiton tenuidontus Saito & Okutani, 1990

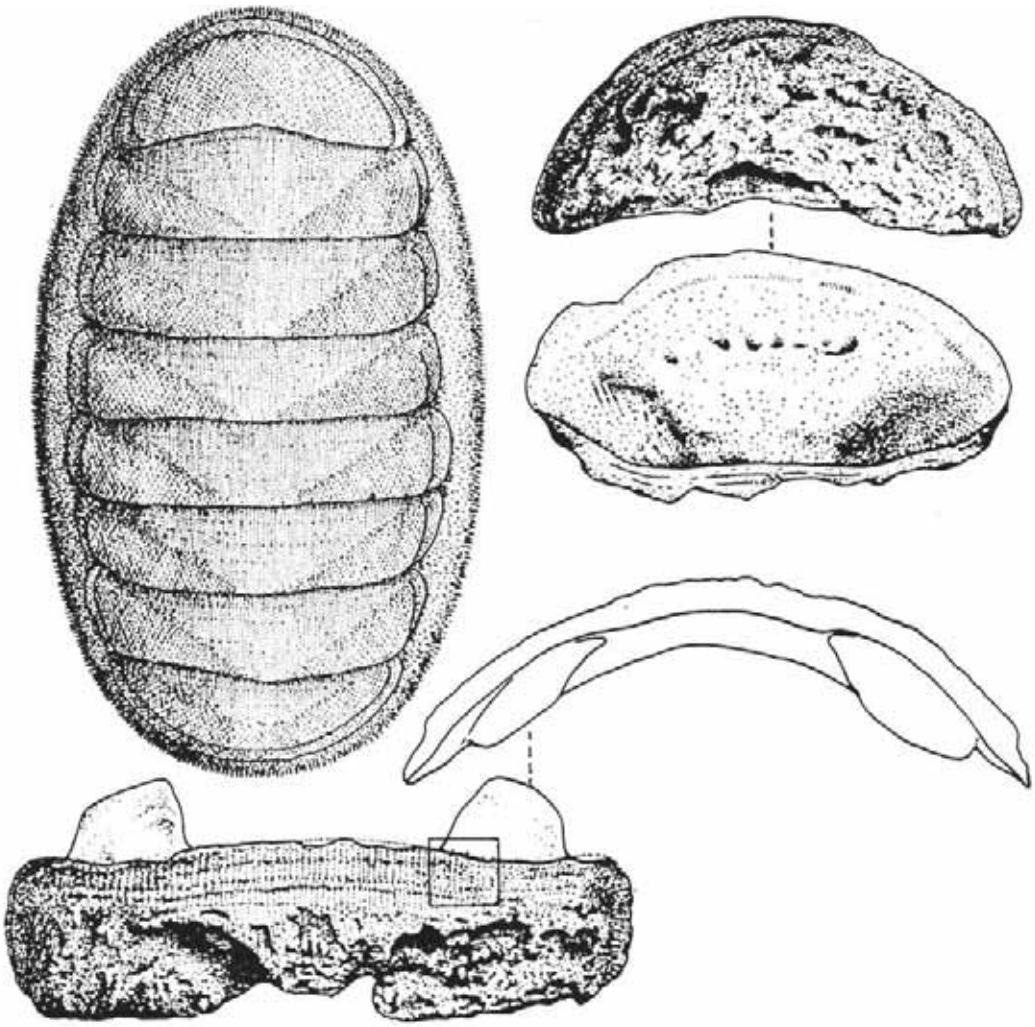
Size: Length up to 16 mm.

Color: Valves pale buff with some blackish deposits, girdle buff in preserved specimens.

Morphology: Animal oblong, moderately elevated, with an evenly rounded back. Girdle narrow, with elongate calcareous scales, each ornamented with 7-8 longitudinal ribs, and with long, smooth, needle-like marginal spiculae. Tegmentum (dorsally visible part of the valves) sculptured with elongated, close-set granules, arranged in longitudinal series. Articulamentum (layer beneath tegmentum) with callus at the middle portion of each valve, sutural laminae roughly sub-triangular and widely separated. Radula long, 7.3 mm in the 16 mm specimen, with 193 densely packed teeth rows in the holotype.

Biology: Found together with the other species *Thermochiton undocostatus* among bivalves *Bathymodiolus* and *Calyptogena*, siboglinid tubeworms and shrimps. It is not yet known whether the two species are endemic to vents or they also occur elsewhere.

Distribution: Okinawa Trough: Iheya Ridge.



1 left: Dorsal view; top right, head valve, exterior and interior; bottom: Valve IV, anterior and dorsal view; after Saito & Okutani (1990).

Reference:

Saito H. & T. Okutani (1990) Venus **49**(3): 165-179.

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Mollusca, Gastropoda

Currently about 60 genera and more than 100 species of gastropods have been recognized in hydrothermal communities in the Indo-Pacific, Indian and Atlantic Oceans. That makes the gastropods the most species-rich group of vent animals thanks to all researchers who have sent specimens to taxonomists for identification. The gastropods are probably also the group where knowledge on distribution and zoogeography is the best.

Although the present handbook aims to present a fairly complete overview with diagnostic information and illustration, it is important to stress several points:

(1) The identification of several genera of small gastropods is difficult and is a matter of specialist work.

(2) The limpets can be assigned to genus based on shell and external morphology only, but many can be confusingly similar on superficial examination by an untrained eye. It is sometimes even easier to identify limpets to species than to genus.

(3) For any work deemed to have results of more than temporary importance and where species identification is involved, it is recommended that voucher specimens are deposited in a recognized scientific museum collection. Many natural history museums readily accept such deposits. For morphological work formalin-fixed specimens are preferred, although also ethanol-preserved specimens can be used. Frozen specimens are usually too macerated to show details in tentacles and epithelia. As always when calcareous shells are involved, do not forget to buffer the formalin, for example with a tea spoon of borax per litre 4% formalin.

1: *Ifremeria nautilei* from Kilo Moana, Lau Back-Arc Basin, TUIM 07 cruise © C.R. Fisher.

(4) Beginning genetic work has revealed existence of isolated genotypes or populations within some of the previously recognized species. In some species this is accompanied by morphological differences and/or geographic separation (e.g. *Lepetodrilus fucensis* JOHNSON et al., in press). In others (e.g. *Alviniconcha hessleri*) there are no noticeable differences in morphology and their geographic distribution is not easily explicable. It should be remembered that distribution, dispersal and speciation of deep-sea animals still is "terra incognita" and should be explored.

(5) This manual may give the impression that the fauna is adequately known. However, many vent inhabitants are still known from a single or very few specimens, and almost every cruise to the site at 13°N on the East Pacific Rise (probably the best known gastropod fauna) has resulted in one or a couple of undescribed species; new species are also likely to be discovered by new expeditions at other "well-known" and "well-collected" sites.

Many gastropods and other hard-bodied animals from vent sites and other reducing environments may have thick crusts of deposited materials covering the surface. These may be black or reddish brown due to the presence of amorphic pyrite (iron sulphide, FeS_2) and rust (ferric oxide-hydroxide mixtures) respectively. SEM examination often reveals intense bacterial growth in protected cracks and crevices, whereas exposed areas seem to be grazed with only a short stub of bacterial filaments in border zones. Exposed areas have smooth and hard surface, but the process behind this transition seems unknown. The description of colours of the gastropod shells and periostracum is based on shells free from deposits. Moreover, the shells of many gastropods are covered by pustules formed by bacteria (P. Dando, pers. comm.; cf. Figure of *Depressigyra*). These may to some extent be host specific since their appearance differs between host species. They have only been observed in vent environments.

References:

JOHNSON P., VRIJENHOEK R.C. & A. WARÉN (in press) Bio. Bull.
SASAKI T., OKUTANI T. & K. FUJIKURA (2005) Venus **64**: 87-133.

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Eulepetopsis vitrea McLean, 1990 "translucent limpets"

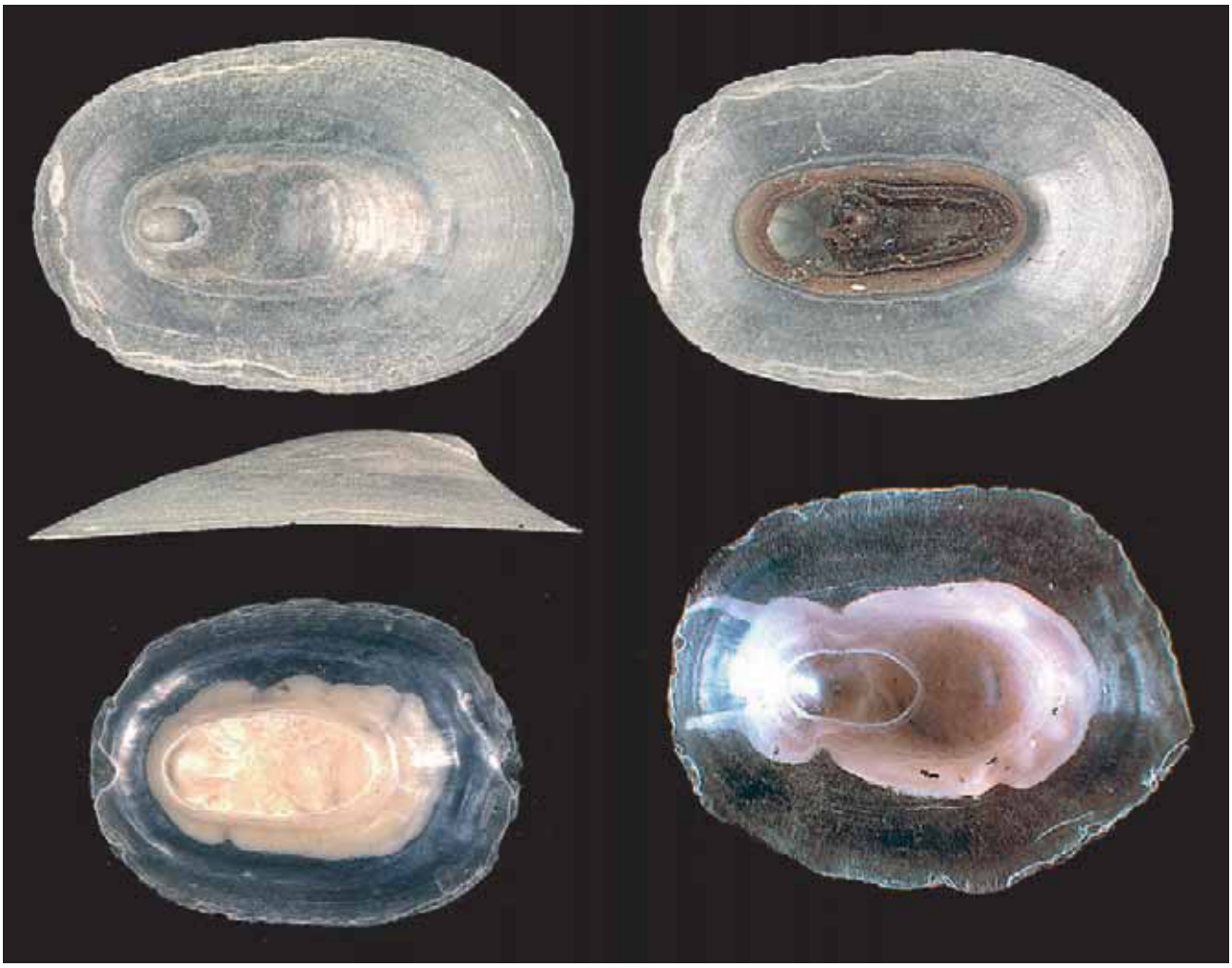
Size: Shell length up to 17 mm.

Morphology: Shell oblong, very flat; apex one-quarter shell length from anterior end; shell smooth on superficial examination, with fine radial striae on closer inspection. Shells immersed in water or ethanol nearly transparent, dried shells white; interior with metallic sheen when viewed at angle. No operculum. No appendage along foot margin

Remarks: An unnamed species known from the Kairei Vent Field (Indian Ocean).

Biology: Specimens have been collected on the basalt substratum and on the mussel *Bathymodiolus*. Genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 21°N to 17°S; Galapagos Spreading Center.



1: Exterior, interior and lateral views; by R. von Cosel, A. Le Goff & P. Briand.

References:

Fretter V. (1990) J. Zool. Lond. **222**: 529-555.
McLean J. (1990) J. Zool. Lond. **222**: 485-528 [503].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [123].

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Neolepetopsis McLean, 1990 "symmetrical limpets"

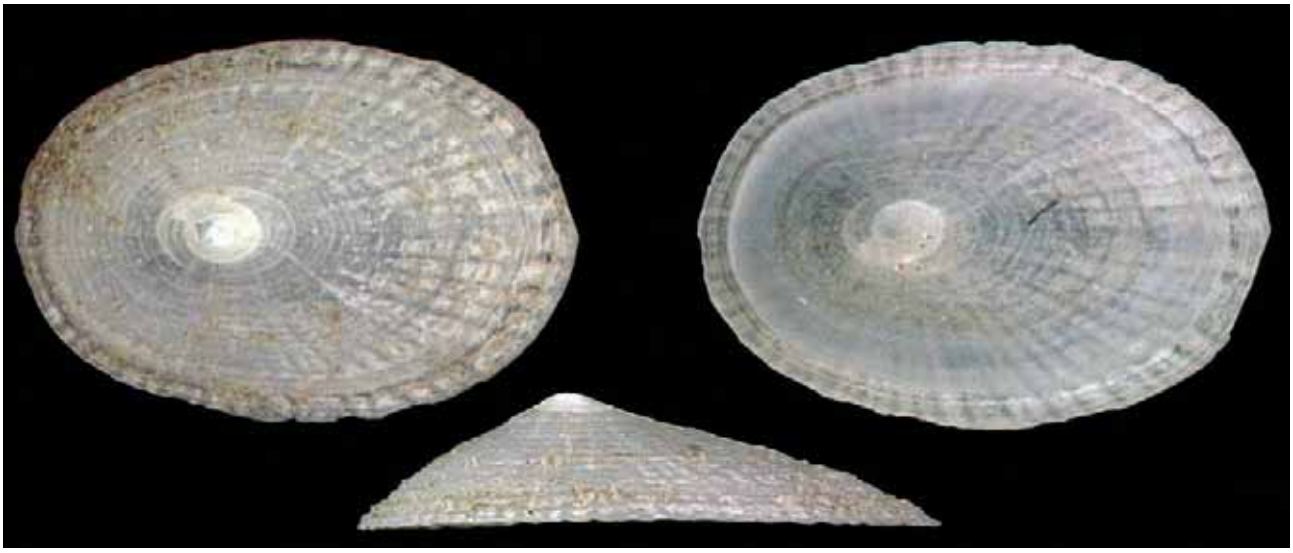
Species	Distribution
N. densata McLean, 1990	East Pacific Rise: 12-13°N, Galapagos Spreading Center
N. gordensis McLean, 1990	Gorda Ridge: 41°N, S Gulf of California: 20°N; possibly also off Peru: 5°S
N. occulta McLean, 1990	East Pacific Rise: 21°N
N. verruca McLean, 1990	East Pacific Rise: 21°N

Size: Shell length up to 4-7.5 mm (varies with species).

Morphology: Shells oblong, depressed; apex 1/3 to 2/5 shell length from anterior end; sculpture of strong beads produced at intersections of radial and concentric ribs. Species differ in details of sculpture. No operculum. No appendage on sides of foot.

Remarks: Demarcation of genus against *Paralepetopsis* uncertain.

Biology: Genus endemic to vents and seeps; some species have been collected on inactive chimneys devoid of other megafaunal species. Larval development lecitotrophic with planktonic dispersal stage. As in *Paralepetopsis*, species demarcation based on morphology is close to impossible since the species are feature-less, variable and often badly corroded (except *N. densata*).



1: *N. gordensis*, exterior, interior and lateral views; by R. von Cosel & A. Le Goff.

References:

Fretter V. (1990) J. Zool Lond. **222**: 529-555.
McLean J. (1990) J. Zool. Lond. **222**: 485-528 [492, 496].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [122-123]

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Paralepetopsis ferrugivora WARÉN & BOUCHET, 2001 "rust-eating limpets"

Size: Shell length up to 17 mm.

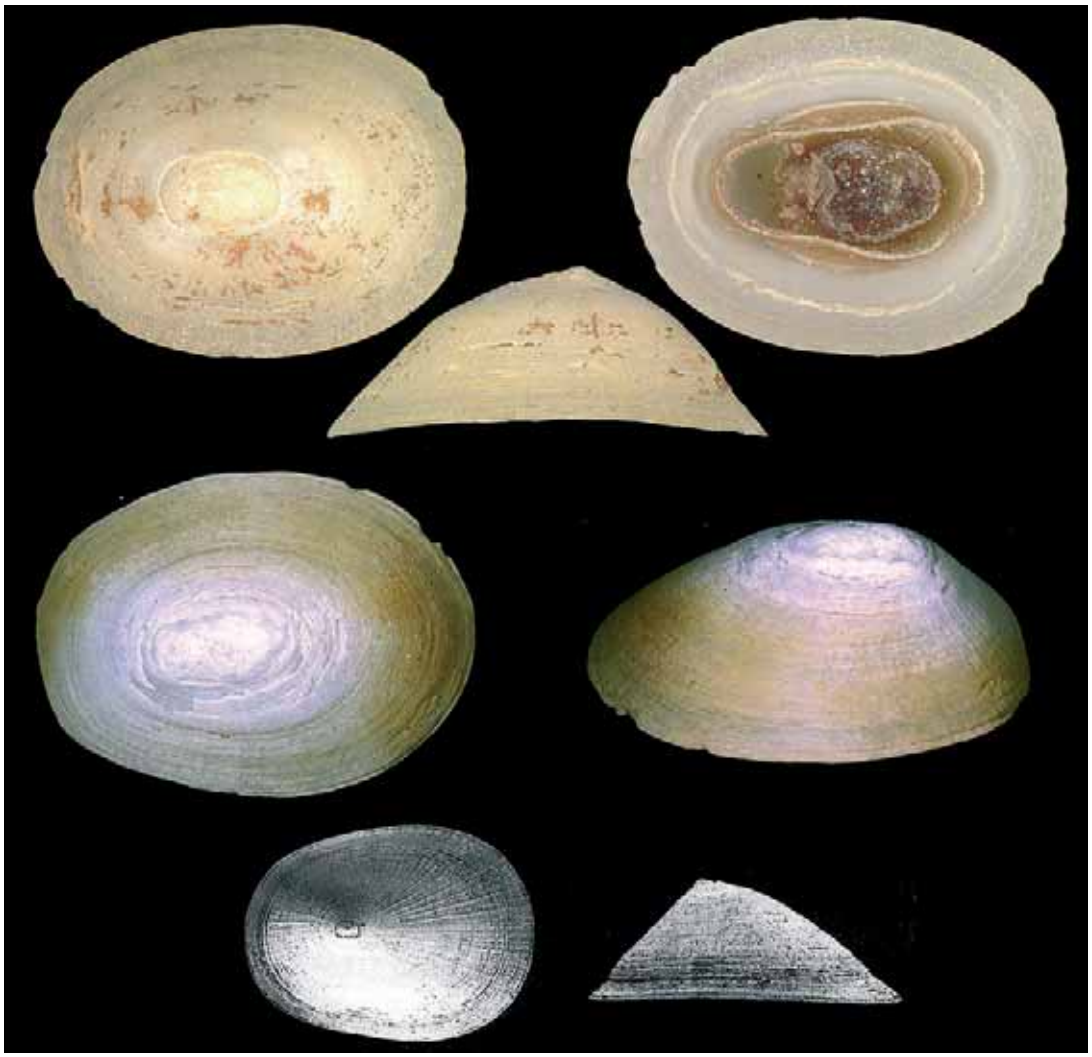
Color: Shell semi-transparent, white or slightly brown; interior whitish.

Morphology: Shell oblong, sturdy, depressed, without trace of coiling; apex one-third shell length from anterior end, always worn; shell with rough surface, numerous radial ribs. No operculum. No remarkable appendage or extension on head or foot margin. Eyes absent.

Remarks: Demarcation of genus against *Neolepetopsis* uncertain. Other species of *Paralepetopsis* are common in seep environments in the Atlantic and eastern Pacific and on whale skeletons off California. They are difficult to identify due to their feature-less external morphology and often corroded shells. Several species adjust the shell to the substrate with a slender outline and concave shell base, when living on tubes.

Biology: Specimens have been collected on and among *Bathymodiolus*. Intestine filled with orange-brown matter of granular structure with nematode and ciliate fragments. Larval development lecithotrophic with planktonic dispersal stage

Distribution: Mid-Atlantic Ridge: Lucky Strike.



1: Exterior, interior and lateral views; by R. von Cosel, A. Le Goff, P. Briand & A. Warén.

Reference:

WARÉN A. & P. BOUCHET (2001) Veliger **44**(2): 116-231 [123-125].

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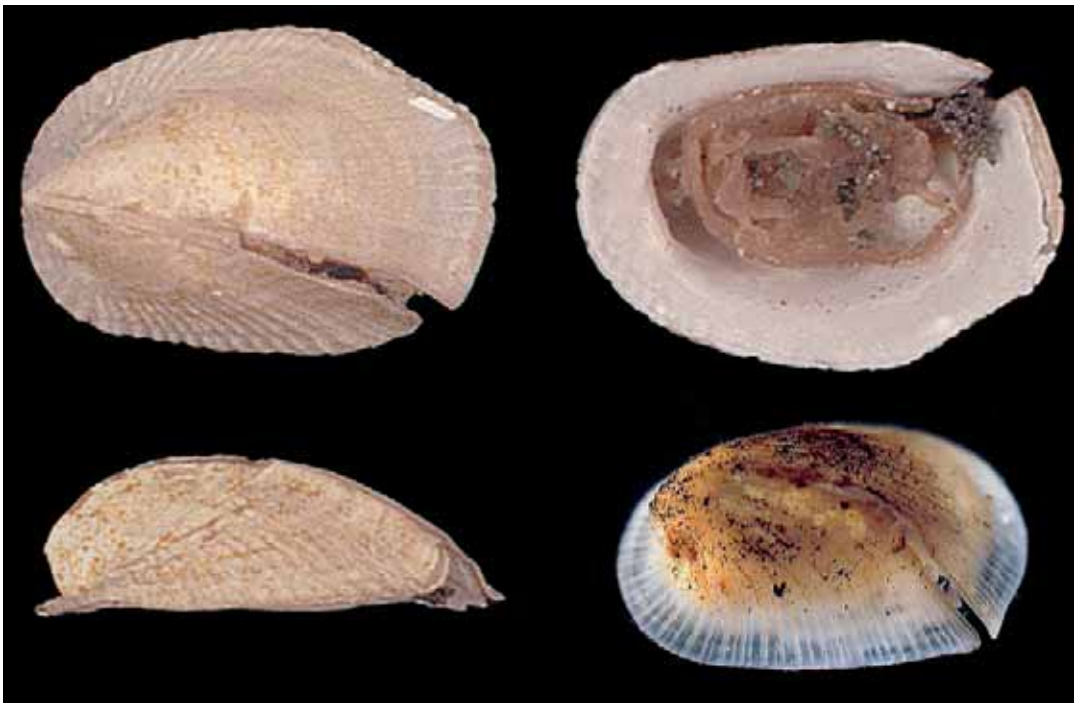
Clypeosectus McLean, 1989 "slit-limpets"

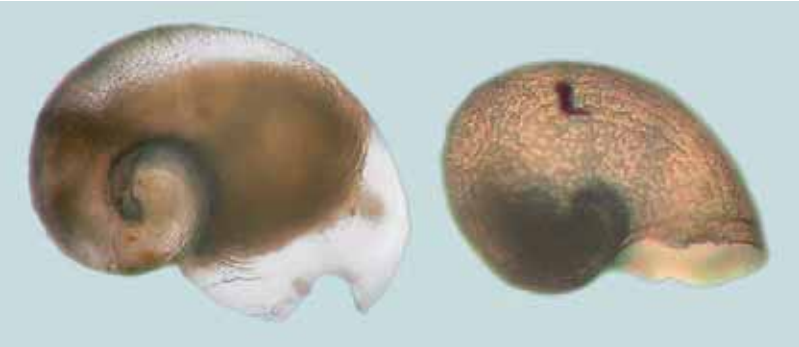
Species	Distribution
C. curvus McLean, 1989	Explorer and Juan de Fuca Ridges
C. delectus McLean, 1989	East Pacific Rise: 13°N and 21°N, Galapagos Spreading Center

Size: Shell length up to 5-8 mm (varies with species).

Morphology: Shells of limpet form with oblique, elongate slit; sculptured by fine radiating ribs. Slit open at margin. No operculum. Eyes absent.

Biology: Found with siboglinid tubeworms, details of habitat not known. Genus endemic to vents.





1: *C. delectus*; top: Exterior and interior view; bottom left, same specimen, lateral view; by A. Le Goff © MNHN; bottom right: Another, inclined view; P. Briand © Ifremer.

2: Larvae; by courtesy of L. Mullineaux.

References:

Haszprunar G. (1989) Nat. Hist. Mus. Los Angeles Cty, Contrib. Sci. **408**: 1-17 [5].
McLean J. (1989) Nat. Hist. Mus. Los Angeles Cty, Contrib. Sci. **407**: 1-29 [18, 21].
Warén A. & P. Bouchet (2001) Veliger **44** (2): 116-231 [155].

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Gorgoleptis McLean, 1988 "dimorphic limpets"

Species	Distribution
G. emarginatus McLean, 1988	East Pacific Rise: 9-21°N
G. patulus McLean, 1988	East Pacific Rise: 13°N, Galapagos Spreading Center
G. spiralis McLean, 1988	East Pacific Rise: 13°N

Size: Shell length up to 3-9 mm (varies with species).

Morphology: Shells depressed, ear-shaped, with a distinctly coiled initial whorl; sculpture of beaded or imbricate radial ribs. Operculum small, not closing the shell. Male with penis formed by expansion of snout on left side. Five pairs of long epipodial tentacles.

Biology: Details of habitat unknown. Genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage

1 top: *G. emarginatus*; middle: *G. patulus* with incrustations; bottom: *G. spiralis*. All with exterior, interior and lateral view; by R. von Cosel & A. Le Goff.

References:

Fretter V. (1988) Philos. Trans. R. Soc. Lond. B **319**: 33-82 [58, 64-65].
McLean J. (1988) Philos. Trans. R. Soc. Lond. B **319**: 1-32 [19-24].
Warén A. & P. Bouchet Veliger **44**(2): 116-231 [154-155].

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Lepetodrilus McLean, 1988 "dimorphic limpets"

Species	Distribution
L. atlanticus Warén & Bouchet, 2001	Mid-Atlantic Ridge: 38-23°N
L. corrugatus McLean, 1993	Juan de Fuca Ridge
L. cristatus McLean, 1988	East Pacific Rise: 13°, 21°N, Galapagos Spreading Center
L. elevatus McLean, 1988	East Pacific Rise: 21°N-17°S, Galapagos Spreading Center, North Fiji Basin, Lau Basin, Mariana Basin
L. fucensis McLean, 1988	Juan de Fuca Ridge
L. galriftensis McLean, *1988*	East Pacific Rise: 9°N, Galapagos Spreading Center
L. guaymasensis McLean, 1988	Guaymas Basin
L. japonicus Okutani, Fujikura & Sasaki, 1993	Okinawa Basin
L. nux Okutani, Fujikura & Sasaki, 1993	Okinawa Basin
L. ovalis McLean, 1988	East Pacific Rise: 21°N-17°S, Galapagos Spreading Center
L. pustulosus McLean, 1988	East Pacific Rise: 21°N-17°S, Galapagos Spreading Center
L. schrolli Beck, 1993	Manus Basin
L. tevnianus McLean, *1991*	East Pacific Rise: 11°N
Further species	Indian Ocean hydrothermal vents

Size: Shell length up to 6-20 mm (varies with species).

Morphology: Shells of limpet form; coiling distinct to indistinct. Apex posterior, lower than highest shell elevation, slightly to strongly projecting. Species differ by shell proportions and sculpture. No operculum. Male usually with penis near base of right cephalic tentacle. Three pairs of short epipodial tentacles.

Biology: At East Pacific Rise sites, specimens of *L. elevatus* have been collected in such abundance from washings of siboglinid tubes that there is no doubt that a primary habitat of these limpets is directly on *Riftia* and *Tevnia*. Association of chemoautotrophic bacteria with the gill confirmed for *Lepetodrilus fucensis*, which has been found in densities of 400000 m^{-2}. The genus occurs in vents and seeps. Development with free-swimming lecithotrophic larvae with planktonic dispersal stage.

Remark: Different genetic types, probably species, occur, especially of the forms similar to *L. elevatus* and *L. schrolli*.

1: *L. atlanticus* from Mid-Atlantic Ridge; left top to bottom: Exterior, interior and lateral view; by R. von Cosel & A. Le Goff; top right: In situ © Ifremer/Atos; bottom right: P. Briand © Ifremer.

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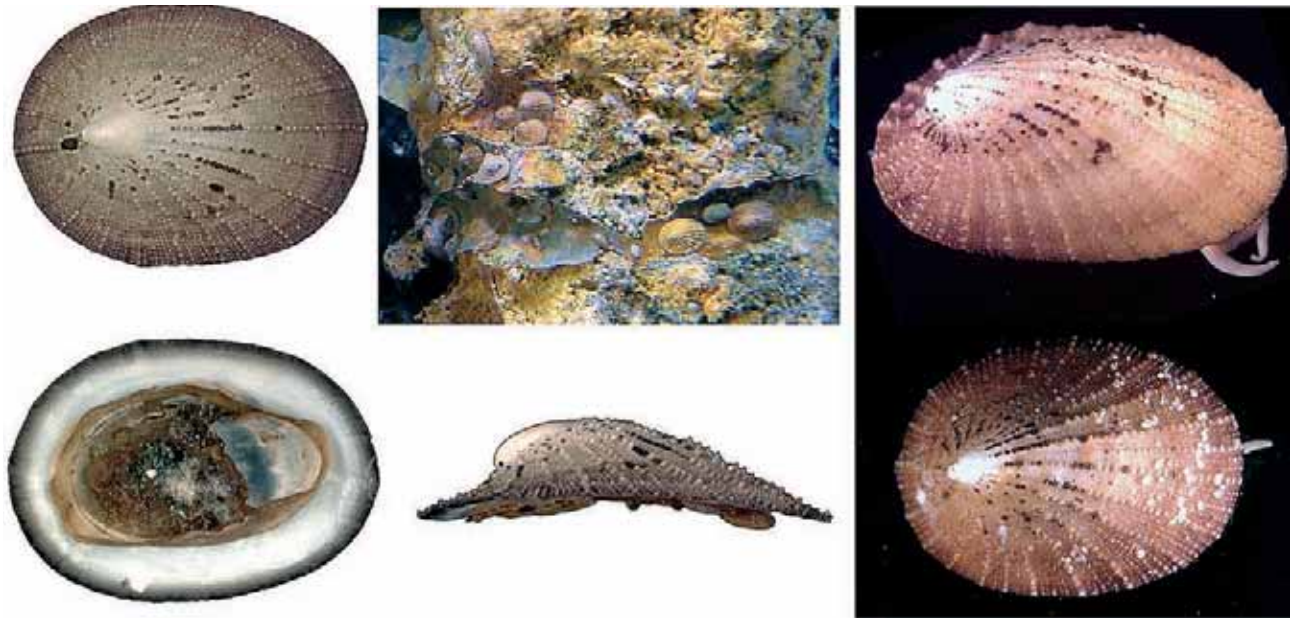
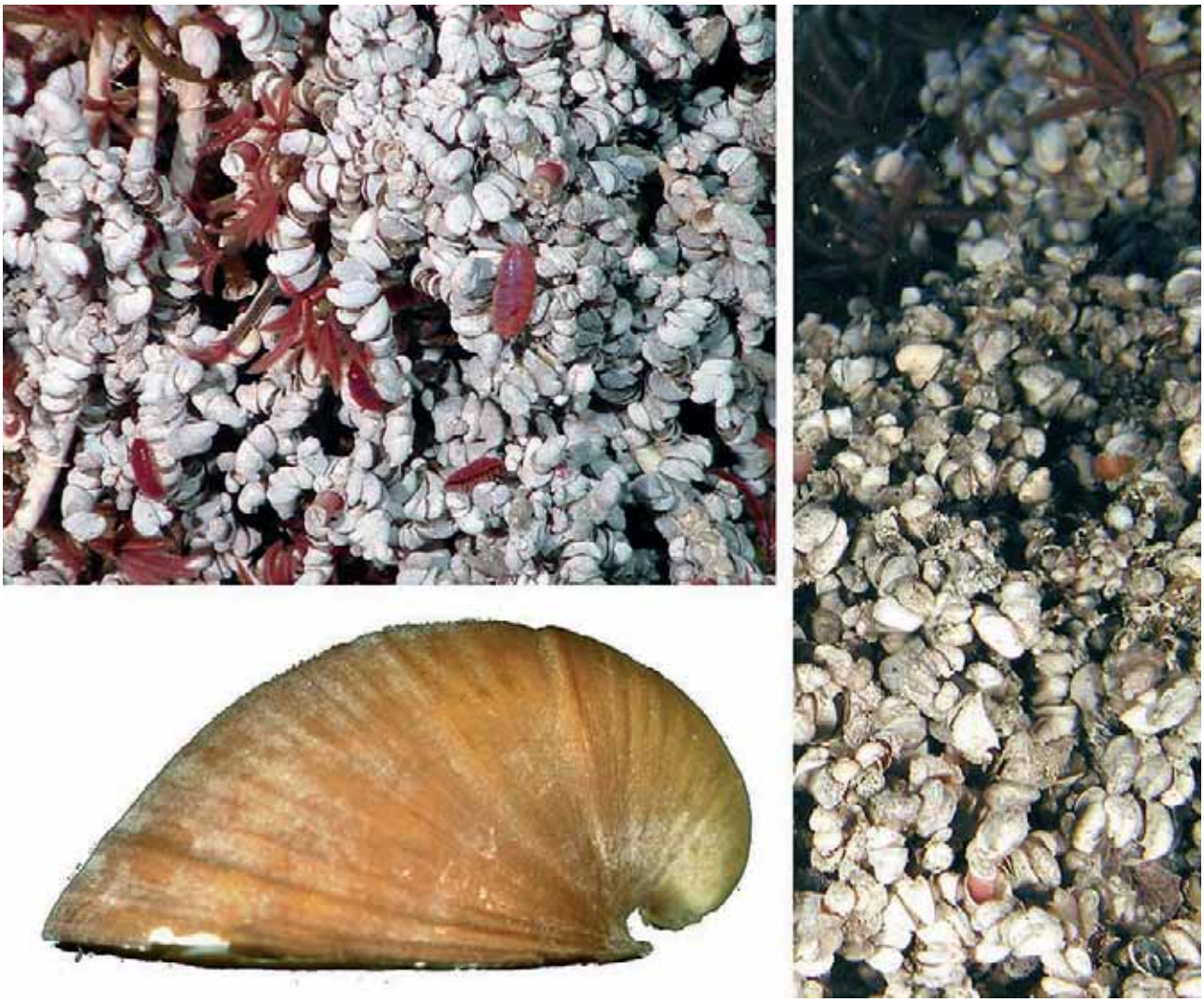


2: *L. cristatus*, on an active chimney, near an alvinellid colony; East Pacific Rise: 13°N; cruise Phare. P. Briand © Ifremer.



3: *L. fucensis*, among tubeworms *Ridgeia picesae*, Juan de Fuca Ridge; by courtesy of K. Juniper.

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4 top: *L. elevatus;* middle: *L. ovalis*; bottom: *L. pustulosus*. All with exterior, interior and lateral view; by R. von Cosel & A. Le Goff; in situ views, limpets on tubes of *Riftia pachyptila* © Ifremer/Phare.

References:

Bates A.E., Tunnicliffe V. & W.L. Raymond (2005) Mar. Ecol. Prog. Ser. **305**: 1-15.

Beck L. (1993) Ann. Nat.hist. Mus. Wien B **94-95**: 167-179.

De Burgh M.E. & C.L. Singla (1984) Mar. Biol. **84** 1-6.

Fretter V. (1988) Philos. Trans. R. Soc. Lond. B **319**: 33-82.

McLean J. (1988) Philos. Trans. R. Soc. Lond. B **319**: 1-32.

McLean J. (1993) Veliger **36**: 27-35.

Okutani T., Fujikura K. & T. Sasaki (1993) Bull. Natn. Sci. Mus.,Tokyo, Ser. A **19**(4): 123-143.

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [143-154].

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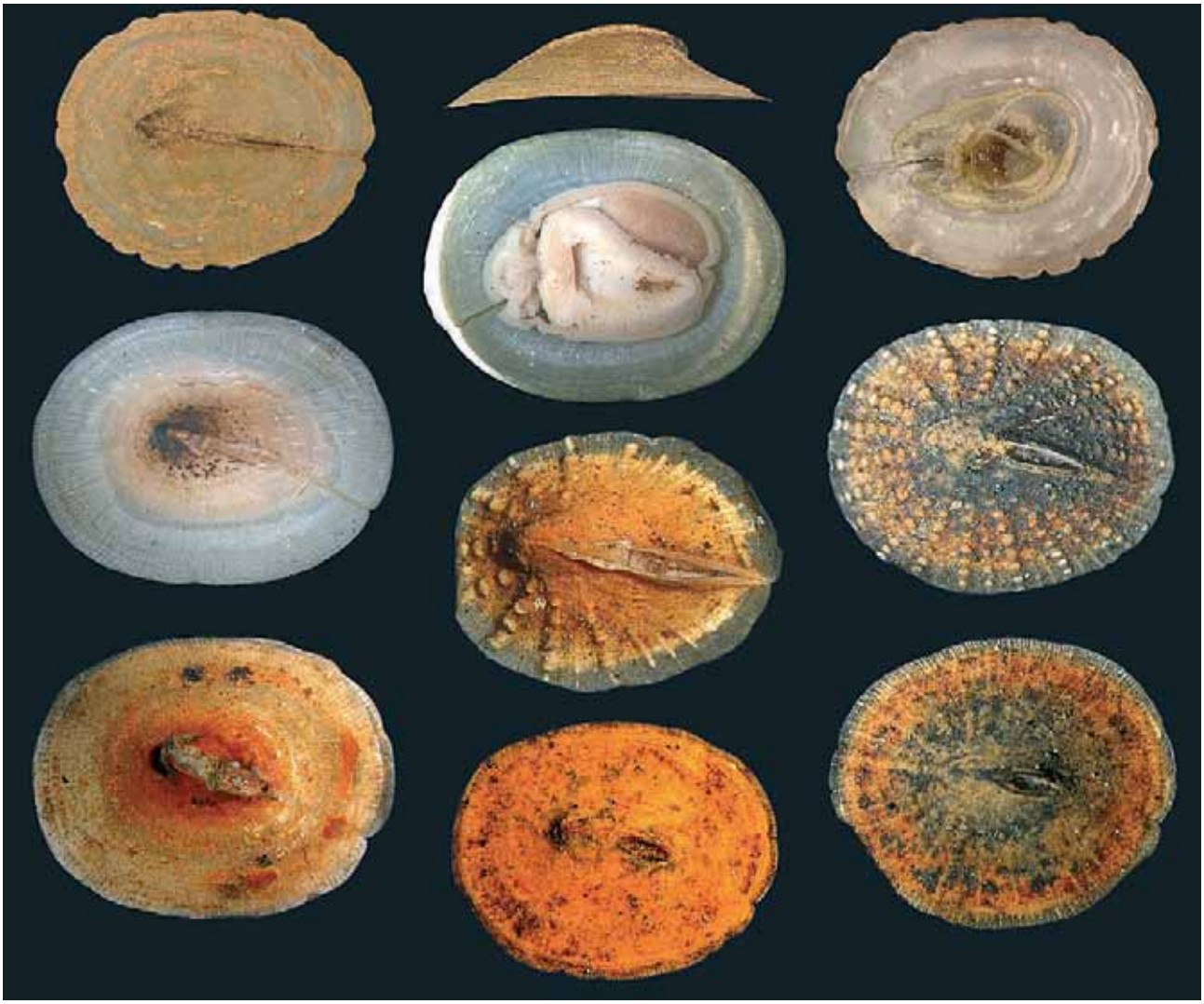
Pseudorimula McLean, 1989 "slit-limpets"

Species	Distribution
P. marianae McLean, 1989	Mariana Back-Arc Basin
P. midatlantica McLean, 1992	Mid-Atlantic Ridge: 38-15°N

Size: Shell length up to 5-8 mm (varies with species).

Morphology: Shells of limpet form with oblique, elongate slit; sculptured by fine radiating ribs. Slit closed at margin. No operculum. Eyes absent.

Biology: On rocks. *P. midatlantica* also occurs on *Bathymodiolus* mussels. Genus endemic to vents. Development without planktotrophic larvae.



1: *P. midatlantica*; top: Dorsal, lateral and ventral view, no precision of origin; by R. von Cosel & A. Le Goff; middle: Specimen from Logatchev (Mid-Atlantic Ridge), dorsal and ventral view; bottom: specimen from Snake Pit; by A. Warén.

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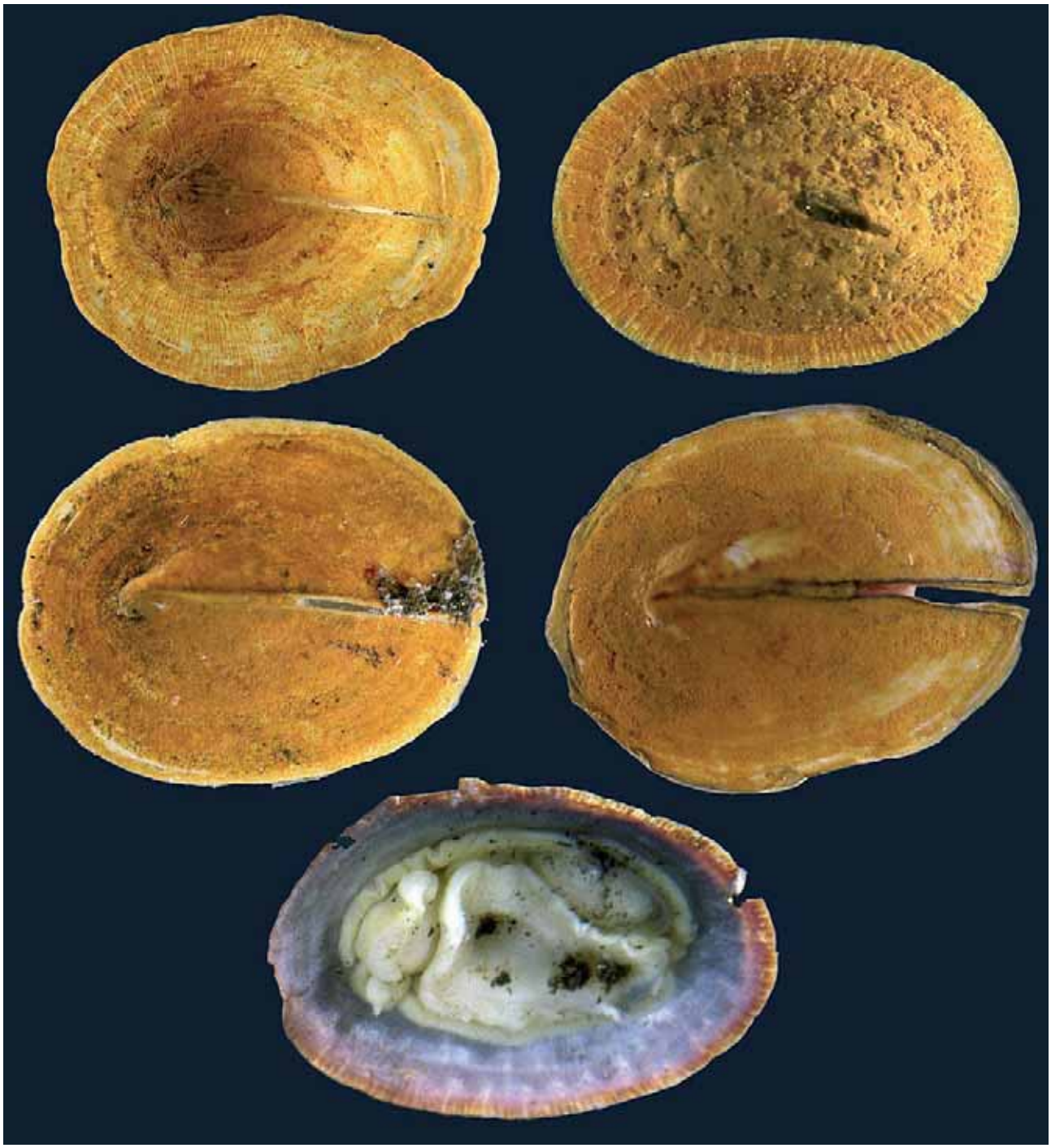

2: *P. midatlantica*; by P. Briand.

References:

McLean J. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **407**: 1-29 [22].
McLean J. (1992) Nautilus **106**: 115-118 [116].
Warén A. & P. Bouchet (2001) Veliger **44** (2): 116-231 [155-157].

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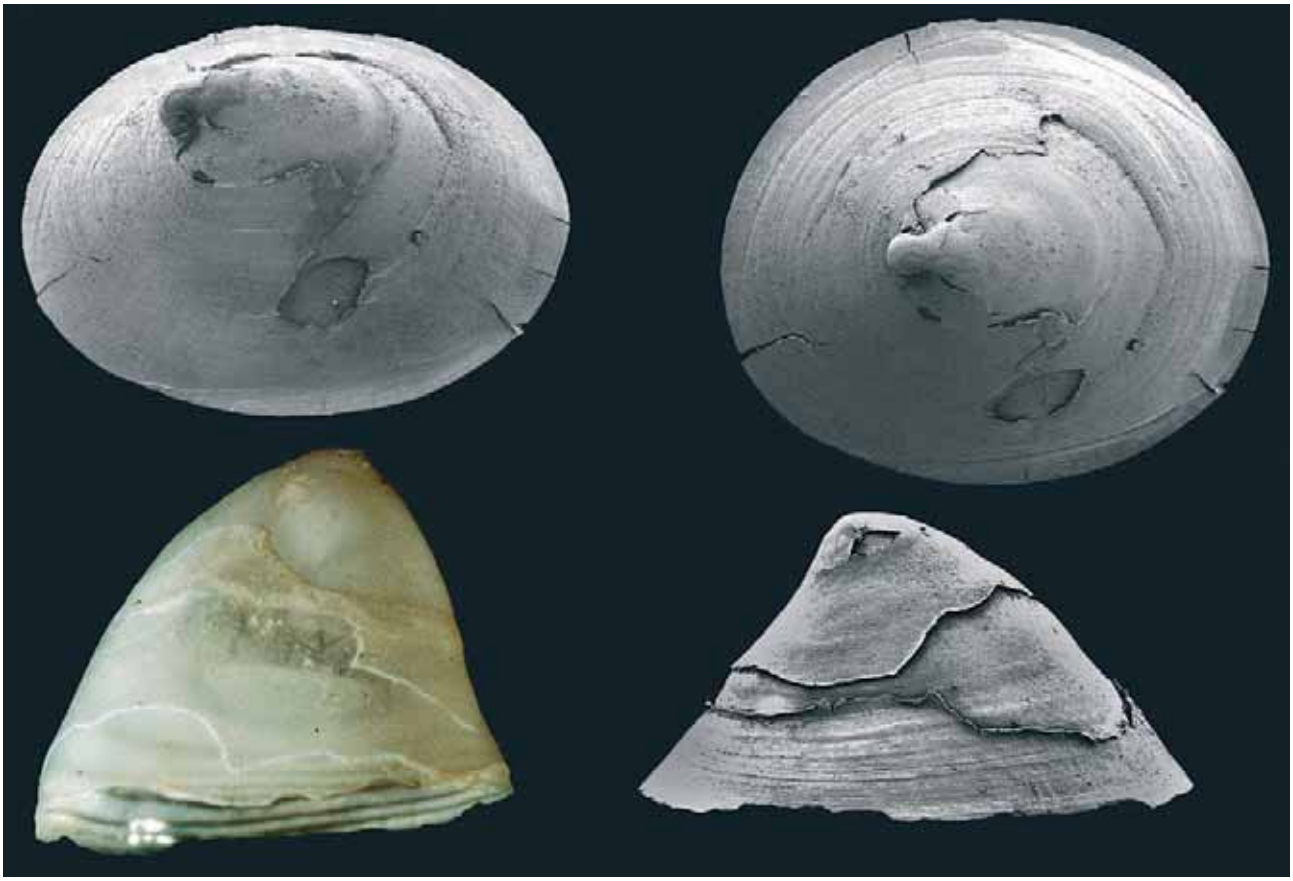
Pyropelta McLean & Haszprunar, 1987

Species	Distribution
P. bohlei Beck, 1996	Lihir Volcano, Edison Seamount, West Pacific
P. corymba McLean & Haszprunar, 1987	Oregon Margin: 45°N, Guaymas Basin
P. musaica McLean & Haszprunar, 1987	Juan de Fuca Ridge: 45°56'N, off California: 36-33°N, Jalisco Block: 20°N
P. yamato Sasaki, Okutani & Fujikura, 2003	Izu-Ogasawara Arc

Size: Shell length up to 5 mm.

Morphology: The family is defined by anatomical characters and the shells are rather featureless, cap-shaped, with central apex; sculpture unknown, exterior surface deteriorated. No operculum. Foot with a pair of posterior epipodial tentacles.

Biology: Specimens have been collected on sulphide crust in the vents and on surrounding rocks, and they are absent in washings of vestimentiferan tubes. *Pyropelta corymba* lives on shells of *Provanna* spp., grazing bacteria. The genus occurs on vents, seeps and also on whale bones. Larval development lecithotrophic with planktonic dispersal stage. The featureless shell, always badly corroded, makes identification very uncertain.



1: *P. corymba*; top left: Inclined and dorsal view of a specimen; right: The same specimen; SEM by A. Warén; bottom left: Lateral view of another specimen, from Guaymas; by P. Briand © Ifremer; bottom right: Another specimen; by J. McLean.

References:

Beck L. (1996) Arch. Moll. **125**: 87-103.
McLean J. & G. Haszprunar (1987) Veliger **30**: 196-205 [197-200].
Sasaki T., Okutani T. & K. Fujikura (2003) Veliger **46**(3): 189-210 [197].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [125-129].

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Bruceiella globulus WARÉN & BOUCHET, 1993

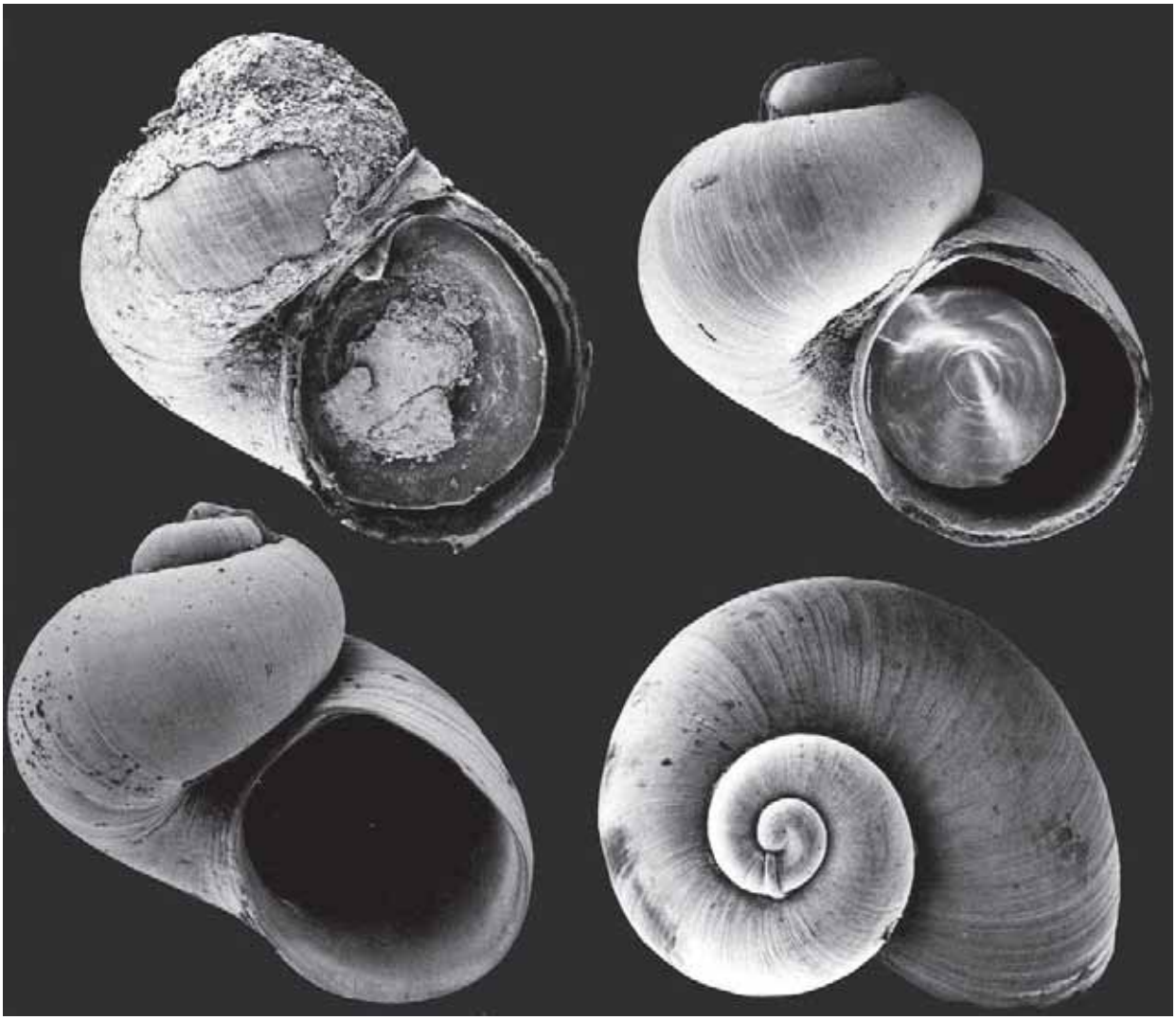
Size: Shell diameter up to 2.3 mm.

Morphology: Shells globular, almost as high as broad, with low spire, rather robust, surface almost smooth. Umbilicus deep and wide. Whorls rounded, with a deep suture, aperture circular, almost or completely detached from the following whorl. Protoconch with spiral sculpture, about 0.65 whorls, with a diameter of about 340 µm. Operculum round, multispiral and thin.

Remark: Another species of this genus, *B. athlia* WARÉN & BOUCHET, 2001, was described from cold seeps of the Aleutian Trench, Shumagin Site, 54°18'N, 157°12'W, 4808 m.

Biology: At hydrothermal vents.

Distribution: North Fiji and Lau Back-Arc Basins.



1 upper left: Specimen 1, 1.19 mm, apertural view, with periostracum; upper right: specimen 2, 1.19 mm, cleaned; both from cruise Biolau, Lau Back-Arc Basin; lower left: specimen 3, apertural view, 2.31 mm; lower right, specimen 4, apical view, 1.9 mm; both cruise Starmer II North Fiji Back-Arc Basin; after WARÉN & BOUCHET (1993).

References:

WARÉN A. & P. BOUCHET (1993) Zool. Scr. **22**: 1-90.
WARÉN A. & P. BOUCHET (2001) Veliger **44**(2): 116-231.

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Fucaria Warén & Bouchet, 1993

Species	Distribution
F. mystax Warén & Bouchet, 2001	S of Lihir, Edison Seamount, West Pacific
F. striata Warén & Bouchet, 1993	Juan de Fuca Ridge

Size: Diameter up to 5.8 mm (*F. mystax*) and 10.6 mm (*F. striata*).

Color: White, greenish or brownish.

Morphology: Shells turbinate, about as high as broad, rather sturdy (only known with top of the shell eroded), almost closed umbilicus; operculum with central nucleus. Surface smooth (*F. mystax*) or sculptured by spiral lirae and groves (*F. striata*). Aperture rounded, completely closed by horny, multispiral operculum. No eyes. Right neck-lobe fused with eye-lobe and equipped with marginal tentacles.

Biology: Species of *Fucaria* occur only in seeps and vents. Food consists of the detritus layer on the bottom (stomach contents consist of mineral particles, sponge spicules and radiolarian fragments in a matrix of mucus and detritus). Larval development lecithotrophic with planktonic dispersal stage.

1: View of different sides of several specimens; by R. von Cosel.

References:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [15-17].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [136-137].

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Leptogyra inflata Warén & Bouchet, 1993

Size: Shell diameter up to 1.32 mm.

Morphology: Shell very small, skeneiform, broader than high, with evenly rounded whorls. Umbilicus deep and broad. Whorls with a deep suture. Protoconch with 0.6 whorls, regularly coiled, the initial part with an irregular net sculpture, the remaining half smooth; diameter 200 µm. Teleoconch with 2.25 whorls, with about nine low and indistinct spiral ribs and axial growth lines. Periostracum thin and transparent. Operculum thin, multispiral, brownish.

Biology: Only known from hydrothermal vent sites.

Distribution: Lau Back-Arc Basin.

1: Holotype, 1.32 mm; top: apical view; bottom left: apertural view wit periostracum and incrustations; bottom right: same specimen, cleaned; cruise Biolau; after Warén & Bouchet (1993).

3: Umbilicus; after Warén & Bouchet (1993).

2: Protoconch; after Warén & Bouchet (1993).

Reference:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90.

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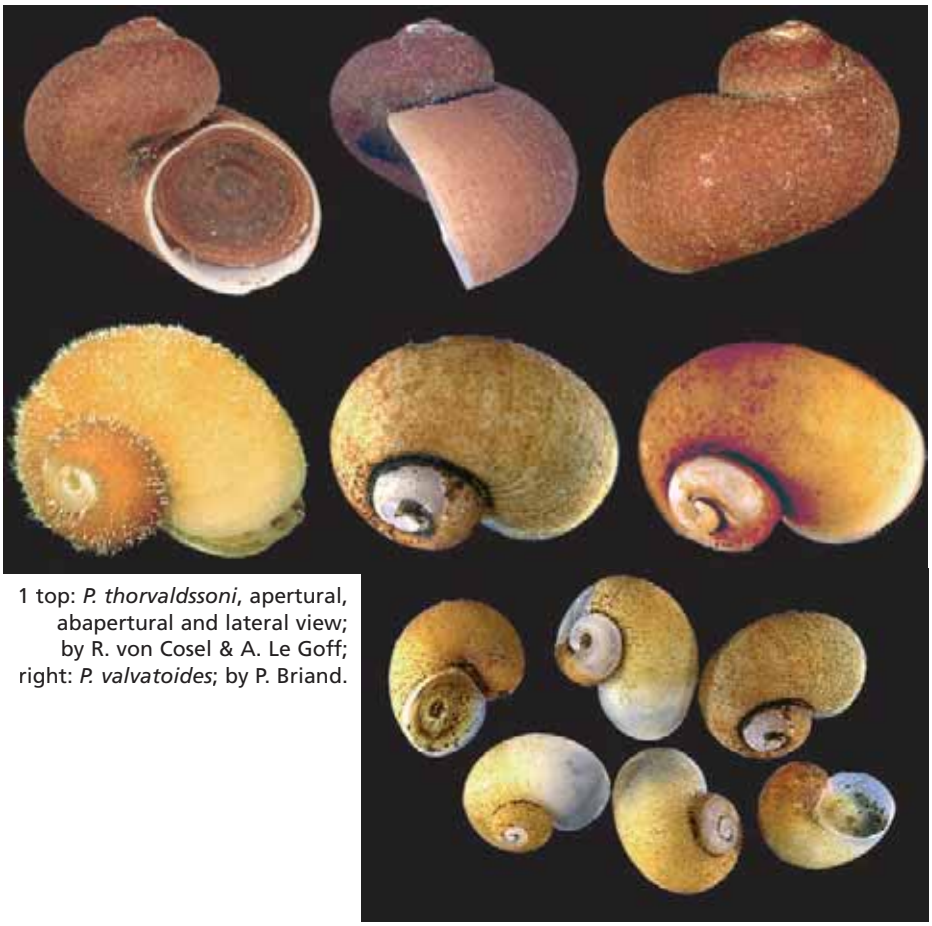
Protolira Warén & Bouchet, 1993

Species	Distribution
P. thorvaldssoni Warén, 1996	Mid-Atlantic Ridge: Snake Pit, to Iceland
P. valvatoides Warén & Bouchet, 1993	Mid-Atlantic Ridge: Menez Gwen and Lucky Strike

Size: Shell diameter up to 4.2 mm.

Morphology: Shells small, fragile, turbinate, about as high as broad or broader than high, with spirally arranged micro-tubercles on the protoconch (spire almost always corroded) and an almost smooth, globular shell with open umbilicus and a deep suture. Aperture circular, completely closed by horny operculum. Shell whitish, greenish, brownish; surface covered by thick periostracum and mineral deposits. Right neck-lobe continuous with eye-lobe. Right anterior corner of propodium drawn out into a spirally coiled tentacle.

Biology: Found among *Bathymodiolus*, on sediment and on rocks, *Protolira thorvaldssoni* also on whale bones, from which it was originally described. Food consists of the detrital surface layer on the bottom (stomach contents consist of a mixture of organic material and mineral particles, scattered sponge spicules, polychaete bristles, diatoms and crustacean fragments). Larval development lecithotrophic with planktonic dispersal stage.



1 top: *P. thorvaldssoni*, apertural, abapertural and lateral view; by R. von Cosel & A. Le Goff; right: *P. valvatoides*; by P. Briand.

References:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [22-26].
Warén A. & P. Bouchet (2001) Veliger **44** (2): 116-231 [138-139].

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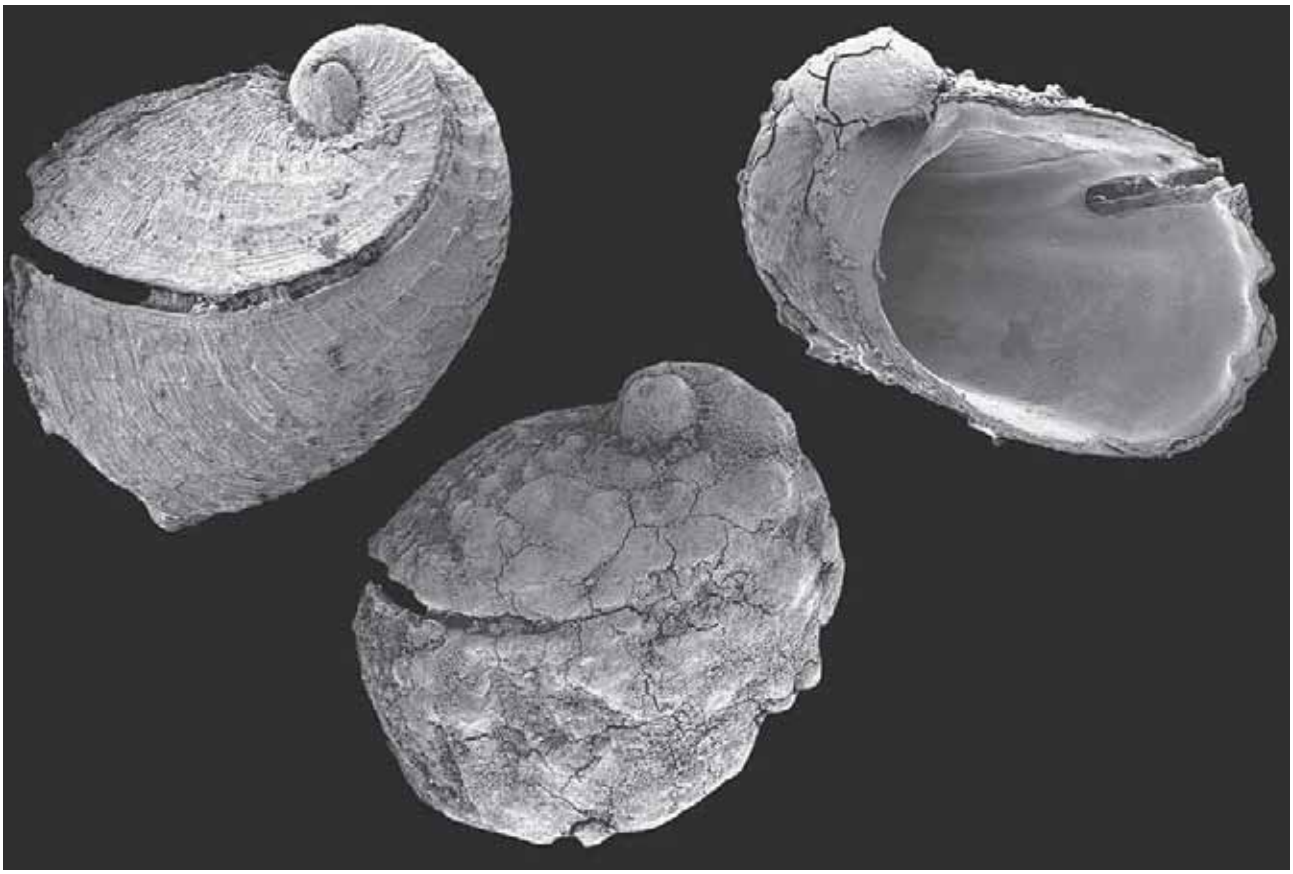
Sutilizona McLean, 1989 "slit-limpet"

Species	Distribution
S. pterodon Warén & Bouchet, 2001	Mid-Atlantic Ridge: Snake Pit,
S. theca McLean, 1989	East Pacific Rise: 12-13°N
S. tunnicliffae Warén & Bouchet, 2001	Juan de Fuca Ridge: Endeavour Segment

Size: Shell length up to 2.4 mm.

Morphology: Shells fragile, limpet-like with long, moderately oblique slit; axial and spiral sculpture of various development. Protoconch with rough pit sculpture. Slit closed (*S. theca*, *S. tunnicliffae*) or open (*S. pterodon*) near the margin. Operculum small and thin, vestigial, multispiral with central nucleus.

Biology: Details of habitat not known. Genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage.



1: *S. pterodon*; two specimens, dorsal views and apertural view (SEM); by A. Warén.

References:

McLean J. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **407**: 1-29 [15].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [141-143].

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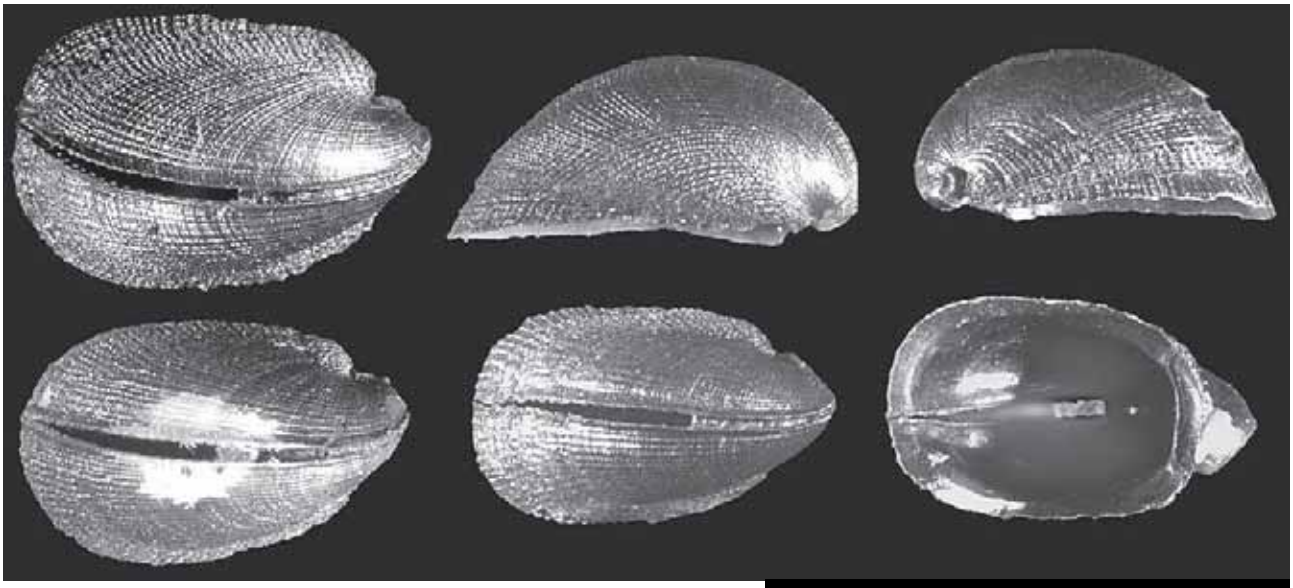
Temnocinclis euripes McLean, 1989 "slit-limpet"

Size: Shell length up to 4 mm.

Morphology: Coiled limpet with long, moderately oblique slit; reticulate sculpture formed by intersection of fine radiating ribs and concentric ridges. Operculum small, vestigial.

Biology: Details of habitat not known. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: Juan de Fuca Ridge.



1: Different views; by R. von Cosel & P. Briand.

2: Specimen, dorsal view; by R. von Cosel & P. Briand.

References:

Haszprunar G. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **408**: 1-17 [3].
McLean J. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **407**: 1-29 [5-7].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [143].

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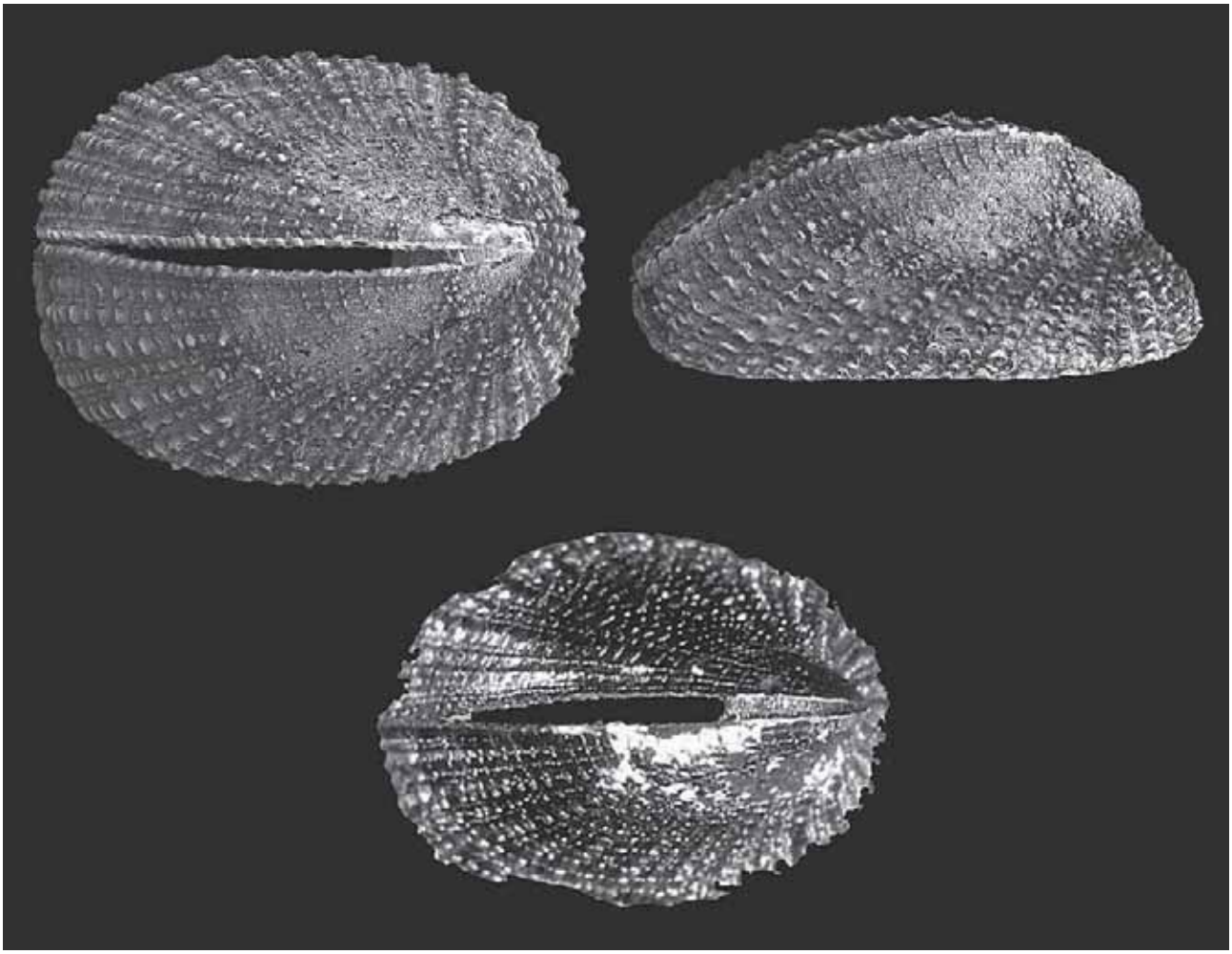
Temnozaga parilis McLean, 1989

Size: Shell length up to 4 mm.

Morphology: Symmetrical limpet with median, oblique, elongate slit; sculptured by strong radiating ribs bearing raised scales. Operculum small, vestigial.

Biology: Details of habitat not known. Monotypic genus endemic in vents. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 21-13°N.



1: Habitus; by A. Warén & P. Briand.

References:

Haszprunar G. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **408**: 1-17.
McLean J. (1989) Nat. Hist. Mus. Los Angeles Cty., Contrib. Sci. **407**: 1-29.

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Bathymargarites symplector Warén & Bouchet, 1989

Size: Shell up to 11 mm.

Color: Off-white.

Morphology: Shell turbinate, about as high as broad, almost smooth, without umbilicus. Umbilical area and columella covered by a solid callus in adult specimens. Interior with a well developed nacreous layer. Eyes at base of cephalic tentacles, but pigment spot of variable shape, sometimes double or absent. Male with left neck lobe modified to function as a penis.

Biology: Specimens have been obtained from rubble samples and washings of *Riftia* and *Calyptogena*. Monotypic genus endemic to vents. Food consists of the detrital surface layer on the bottom. Stomach content consists of mineral particles, sponge spicules, polychaete bristles, crustacean and diatom fragments, radiolarian tests in a matrix of undefined organic matter. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 13°N and 21°N.

1 top: Specimen 1, apertural, abapertural and lateral view by A. Le Goff © MNHN; bottom: Specimen 2, inclined dorsal view, apertural view, inclined basal view; by P. Briand © Ifremer.

2: Larva; by courtesy of L. Mullineaux.

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [87-94].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [11-13].

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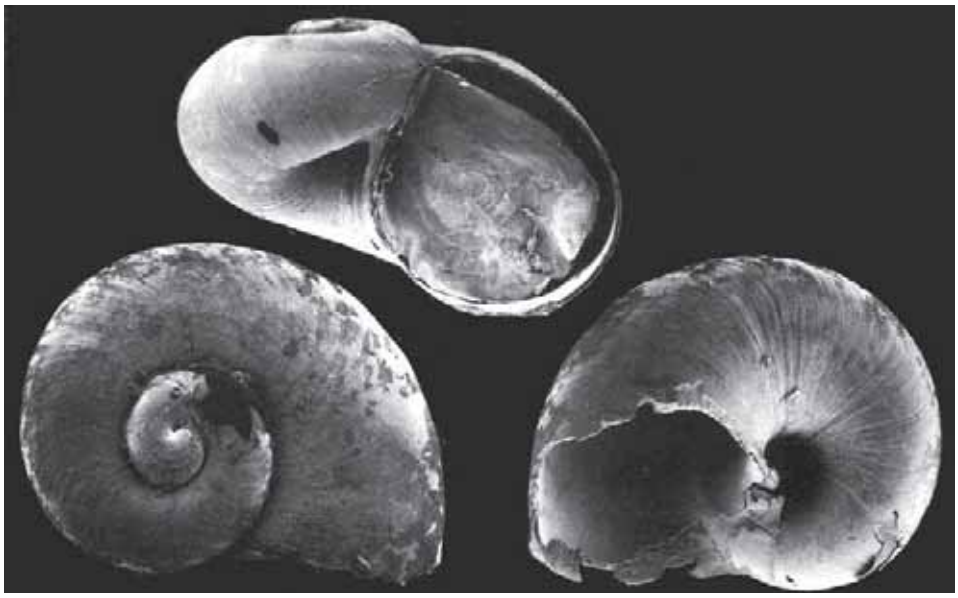
Helicrenion reticulatum Warén & Bouchet, 1993

Size: Shell diameter up to 1.56 mm.

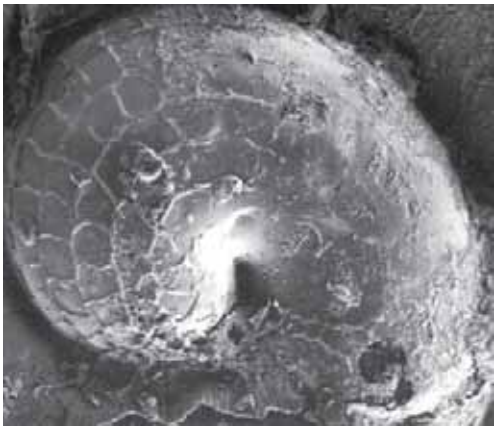
Morphology: Shell very small, skeneiform, like a vitrinellid, depressed, fragile, with an almost smooth surface. Umbilicus widely open, without any basal area or spiral sculpture. Whorls with a deep suture. Protoconch with 0.6 whorls, the initial part with sharp spiral lines and irregularly spaced axial lines, forming a large-meshed net sculpture, later half smooth. Teleoconch with about 1.5 rapidly increasing whorls, with very fine, close-set granular incremental axial lines. Animal not known, radula with unusual few marginal teeth for a neomphalid radula type.

Biology: Known only from hydrothermal vent sites.

Distribution: Only known from Lau Back-Arc Basin: Hine Hina vent field.



1 top: holotype apertural view, 1.56 mm; bottom: paratype 1.10 mm, apical and basal view; Lau Basin; from Warén & Bouchet (1993).



2: Protoconch showing reticulated sculpture; Lau Basin; from Warén & Bouchet (1993).

3: Protoconch showing umbilicus; Lau Basin; from Warén & Bouchet (1993).

Reference:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90.

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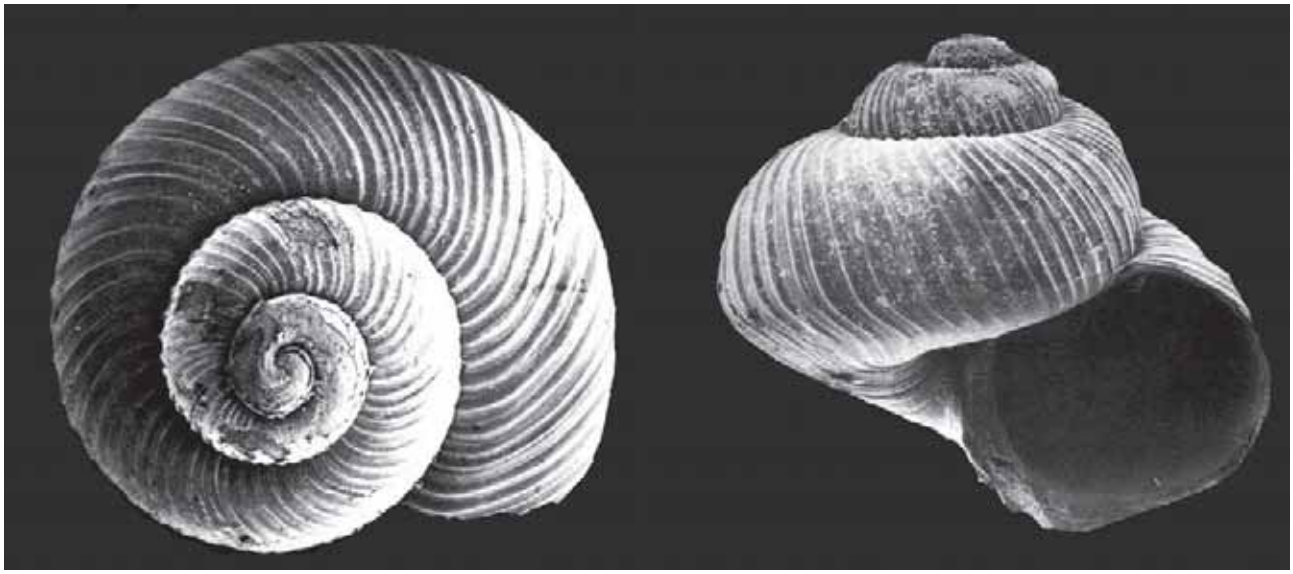
Vetulonia phalcata Warén & Bouchet, 1993

Size: Shell diameter up to 1.24 mm.

Morphology: Shell trochiform, thin and fragile, with regular and sharp axial ribs parallel to the outer lip, ribs basally distincly flexuous. Deep, narrow umbilicus which has an indistinct, steeply ascending spiral rib. Whorls slightly depressed, with a deep suture. Surface between the axial ribs almost smooth. Protoconch with 0.65 whorls, strongly corroded, with a diameter of at least 200 µm; teleoconch with 2.45 whorls; operculum round, multispiral, thin and transparent. Animal not known.

Biology: At vent sites; it is likely that the species feeds on superficial detritus and bacterial film on the bottom, like many other deep water archaegastropods.

Distribution: North Fiji Back-Arc Basin.



1: Holotype, 1.06 mm; left apical view; right apertural view: collected during the cruise Starmer II; after Warén & Bouchet (1993).

Reference:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90.

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Cyathermia naticoides Warén & Bouchet, 1989

Size: Shell diameter up to 7 mm.

Color: White.

Morphology: Shell globular, regularly coiled, without sculpture. Adults with deep notch in the lower part of the outer lip. Very large bipectinate gill. Left cephalic tentacle modified to a penis.

Biology: Specimens have been found in abundance in washings of *Riftia* tubes, more rarely with *Alvinella* tubes. Monotypic genus endemic to vents. Probably a filter-feeder, possibly in combination with cleaning the worms' tubes of bacterial growth. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 9-21°N.

1: Apertural, abapertural and lateral views; by R. von Cosel, A. Le Goff & P. Briand.

2: Larva; by courtesy of L. Mullineaux.

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [69-70].
Warén A. & P. Bouchet (1993) Zool. Scr. **22** (1): 1-90 [33].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [158].

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Lacunoides Warén & Bouchet, 1989

Species	Distribution
L. exquisitus	Galapagos Spreading Center
L. vitreus	Juan de Fuca Ridge: Axial Seamount – Ashes vent field

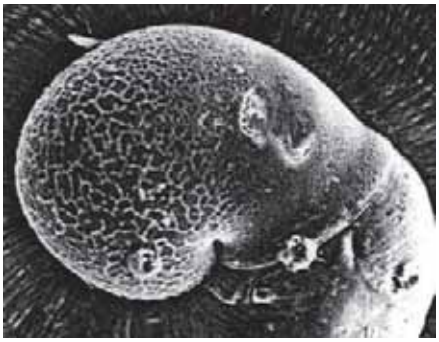
Size: Shell diameter up to 2.5 mm.

Morphology: Shells small, thin and fragile, colourless and transparent, globular, with low, depressed spire, large aperture and rapidly increasing diameter of the whorls. Surface with fine, dense, sometimes slightly irregularly spaced, sharp axial lines or low lamellae and still finer, dense spiral striations. Umbilicus not present or indistinct. Whorls round with a deep suture. Protoconch with diameter of 160 µm (*L. exquisitus*) or 180 µm (*L. vitreus*), about 0.5 whorls, the initial part with irregular net sculpture, later half smooth. Teleoconch with 2.25 (*L. exquisitus*) or about 2 (*L. vitreus*) round whorls. Operculum multispiral, thin and without color, slightly larger than the aperture.

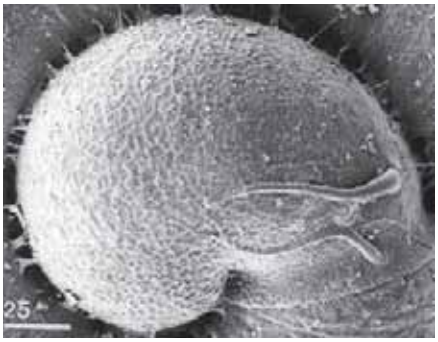
Biology: Near hydrothermal vents on mussel beds or on other hard substrate.

1: *L. exquisitus*, top specimen 1, apertural view, 3.4 mm; bottom specimen 2, apical view, 2.3 mm; from Warén & Bouchet (1989).

3: *L. vitreus*, top holotype, apertural view, 2.4 mm; bottom paratype, apical view, 2.2 mm; from Warén & Bouchet (1989).



2: *L. exquisitus*, close-up of protoconch of the same specimen; from Warén & Bouchet (1989).



4: *L. vitreus*: close-up of protoconch of the same paratype; from Warén & Bouchet (1989).

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102.
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231.

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Melanodrymia Hickman, 1984

Species	Distribution
M. aurantiaca Hickman, 1984	East Pacific Rise: 13°N, 21°N-17°S
M. brightae Warén & Bouchet, 1993	Juan de Fuca Ridge: Endeavour segment
M. galeronae Warén & Bouchet, 2001	East Pacific Rise: 13°N
Melanodrymia sp. "rust covered"	East Pacific Rise: 13°N

Size: Shell diameter up to 3.5 mm.

Color: Rusty orange (M. *aurantiaca*) or whitish (M. *brightae*).

Morphology: Shells depressed (M. *aurantiaca*, M. *brightae*) or higher than broad (M. *galeronae*) with one or two strong peripheral keels. Umbilicus open. Surface of shell above and below keel covered by raised riblets. Most specimens have a thick mineral crust.

Biology: Genus with three species endemic in vents. The species are locally common in washings of *Riftia*, *Ridgeia*, *Calyptogena* and *Alvinella*. Genus endemic to vents. Food consists of the detrital surface layer of the bottom. Larval development lecithotrophic with planktonic dispersal stage.

1: Top: *M. aurantiaca*; by R. von Cosel; middle: *M. aurantiaca*; by P. Briand © Ifremer; bottom: *M. galeronae*; by A. Warén.

2: *M. aurantiaca*; by P. Briand © Ifremer.

References:

Haszprunar G. (1989) Acta Zool. **70**: 175-186.
Hickman C.S. (1984) Zool. Scr. **13**: 19-25 [19-20].
Warén A. & P. Bouchet 1989) Zool. Scr. **18**: 67-102 [75].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**(1): 1-90 [41-44].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [158-161].

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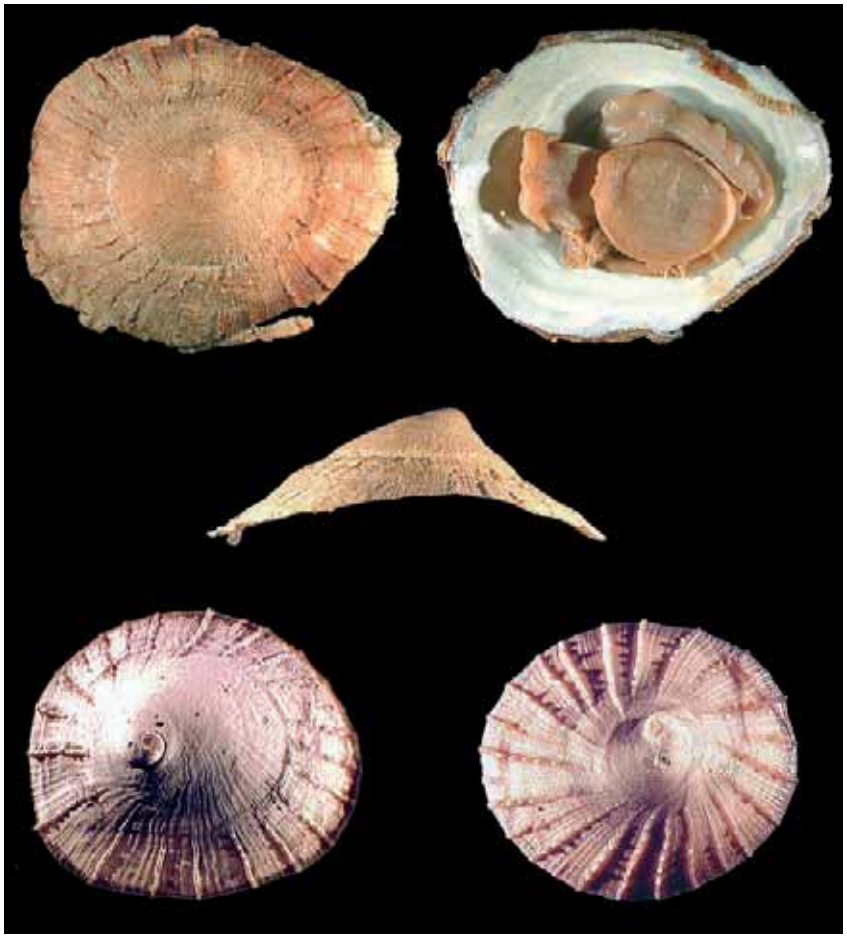
Neomphalus fretterae McLean, 1981

Size: Shell diameter up to 30 mm.

Morphology: Shell cap-shaped with coiled apical whorl, apex subcentral, sculptured with fine radiating ribs. No trace of operculum. Head with long neck, no snout, left cephalic tentacle enlarged.

Biology: Occurs locally in dense aggregations on the walls of the vents. The Neomphalidae are endemic to vents. Probably filter feeder. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: Common at Galapagos Spreading Center, rare at the East Pacific Rise: 9-21°N.



1: Habitus; by R. von Cosel & P. Briand.

2: Habitus; by R. von Cosel & P. Briand.

3: In situ specimens, from East Pacific Rise: 13°N © Ifremer.

References:

Fretter V., Graham A. & J. McLean (1981) Malacologia **21**: 337-361.
McLean J. (1981) Malacologia **21**: 291-336 [294].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [162].

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Pachydermia Warén & Bouchet, 1989

Species	Distribution
P. laevis Warén & Bouchet, 1989	East Pacific Rise: 21°N -17°S
P. sculpta Warén & Bouchet, 1993	North Fiji and Lau Back-Arc Basins

Size: Shell height up to 4.6 mm.

Morphology: Shell small and rather fragile, regularly coiled, up to 3.5 whorls, with part of the body whorl disjunct and with circular aperture. Surface of protoconch net-sculptured, teleoconch with fine incremental and indistinct spiral lines, otherwise smooth. Shell beige to greenish, interior not nacreous; periostracum thick. Specimens are often encrusted with mineral deposits. Operculum multispiral, closing the aperture completely.

Biology: Many specimens found in washings of tubes of *Alvinella* and siboglinids but both species seems to occur also on other substrates. Genus endemic to vents. Stomach contents indicate detritus feeding. Larval development lecithotrophic with planktonic dispersal stage.

1 top left to right: Apertural, abapertural and lateral view of *P. laevis*; by A. Le Goff © MNHN; bottom: another specimen; by P. Briand © Ifremer.

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [75-80].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [40-41].
Warén A. & P. Bouchet (2001) Veliger **44** (2): 116-231 [161-162].

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Planorbidella Warén & Bouchet, 1989

Species	Distribution
P. depressa Warén & Bouchet, 1993	Lau Back-Arc Basin: Hine Hina
P. planispira Warén & Bouchet, 1989	East Pacific Rise: 21°N-17°S

Size: Shell diameter up to 5.1 mm (*P. planispira*) and 1.56 mm (*P. depressa*).

Morphology: Shells flat-spired, regularly coiled, aperture almost circular and strongly prosocline, umbilicus very wide and deep. Surface smooth (*P. planispira*) or with strong, oblique axial ribs and fine spiral cords (*P. depressa*), protoconch with fine-mesh net sculpture. Last part of the body whorl detached. Operculum multispiral, completely closing the aperture. Specimens may be partly encrusted with mineral deposits.

Biology: Found in washings of tubes of *Alvinella* and siboglinids. Genus endemic to vents. Stomach contained only undefined organic material. Larval development lecithotrophic with planktonic dispersal stage.

1 top left, right and bottom: Dorsal, ventral and apertural view of *P. planispira*; by R. von Cosel & A. Le Goff.

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [81-82].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [35-39].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [162].

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Symmetromphalus McLean, 1990

Species	Distribution
S. hageni Beck, 1992	Manus Back-Arc Basin
S. regularis McLean, 1990	Mariana Back-Arc Basin
Symmetromphalus sp.	North Fiji and Lau Back-Arc Basins

Size: Shell length up to 14-21 mm (varies with species).

Morphology: Shells of limpet form with coiled apical whorl, sculptured by finely beaded radial ribs. Operculum small, vestigial. Head with long neck, no snout, left cephalic tentacle of male enormously distended, bearing a deep sperm groove connected to neck groove. Gill large, overlying head.

Biology: *Symmetrophalus regularis* occurs in dense aggregations on the walls of vents; the species at Lau and Fiji lives on mussels and on the subsutural ramp of *Ifremeria nautilei*. Endemic to vents. Sexually dimorphic, with males much smaller. Feeding biology not known. Pallial furrow and especially epipodial tentacles with growth of large filiform bacteria. Larval development lecithotrophic with planktonic dispersal stage.

1: *S. regularis*; by R. von Cosel & P. Briand.

References:

Beck L. (1992) Ann. Nat.hist. Mus. Wien B **93**: 243-257.
McLean J. (1990) Nautilus **104**: 77-86.

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Ctenopelta porifera Warén & Bouchet, 1993

Size: Shell length up to 10 mm.

Morphology: Shell depressed, ear-shaped, sculptured with a dozen spirally arranged rows of hollow conical tubercules connected via pore to the interior of the shell. Surrounding the tubercules are soft, tubular hollow appendages of organic material. No eyes. Sides of foot and epipodium finely setose; posterior part of visceral mass carrying warts corresponding to the pores in the shell.

Biology: Genus with a single species endemic to vents. Specimens have been rarely collected in washings of tubes of *Tevnia* and *Riftia* or sulphide crusts. The setae of the foot and the strange tubular processes on the back of the shell may be involved in some kind of symbiosis with chemosynthetic organisms (?). Sexes separate, females larger than males. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 13°N.

1: Several specimens; by R. von Cosel.

References:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [33-35].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [170].

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Depressigyra globulus Warén & Bouchet, 1989

Size: Shell diameter up to 5.4 mm.

Color: Shell greenish to brownish, interior not nacreous. Periostracum thick, brownish green.

Morphology: Shell broader than high with rather large body whorl, about three whorls; aperture subcircular with an indistinct shallow basal notch. Umbilicus reduced to a small chink, suture deep. Protoconch strongly ridged, teleoconch with irregular incremental lines, otherwise smooth. Operculum multispiral, densely coiled, with central nucleus. Animal with tentacles of even size in both sexes and a snout of approximately even width.

Biology: On vestimentiferan tubes, extremely common. Occasionally, near acidic outflows, the calcareous layer may be dissolved and the living animal is surrounded only by the strong periostracum. Monotypic genus endemic to vents. Stomach contains amorphous organic matter. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: Juan de Fuca Ridge.

1: Several specimens; by R. von Cosel © MNHN.

References:

Bates B. & V. Tunnicliffe (2006) Mar. Ecol. Prog. Ser. **305**: 1-15.
Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [80-81].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [35].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [173].

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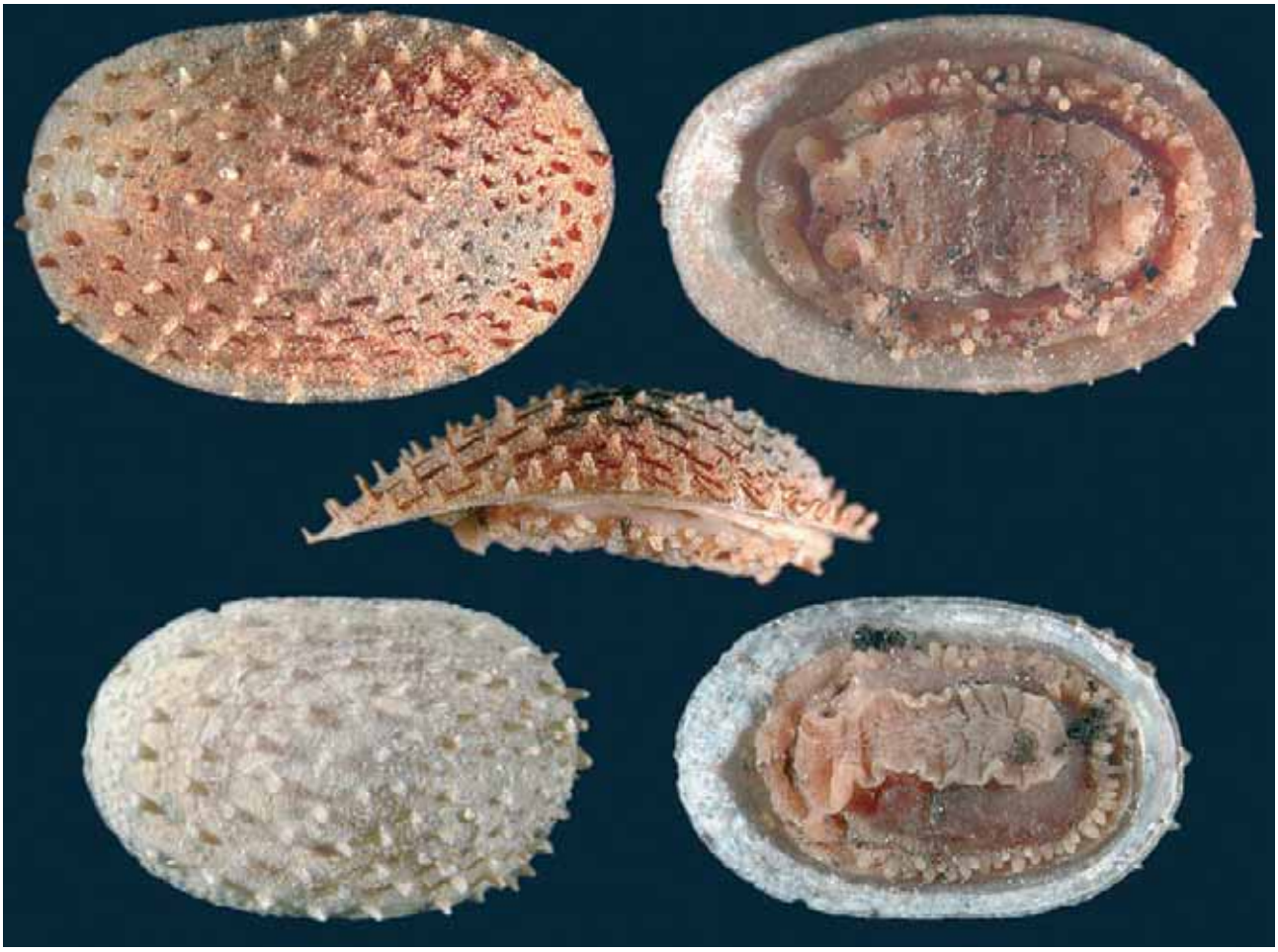
Echinopelta fistulosa McLean, 1989 "tapersnout limpet"

Size: Shell length up to 9 mm.

Morphology: Shell of limpet form, apex close to posterior margin but left of center. Sculpture with widely spaced tubular spines. Periostracum thick. Large specimens coated with rust coloured iron deposits. No operculum. Mantle edge bearing numerous, crowded and elongate tentacles.

Biology: Common on outer face of active black smokers. Monotypic genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 21°N, 13°N.



1: Two specimens in various views; by R. von Cosel.

References:

Fretter V. (1989) J. Zool. Lond. **218**: 123-169.
McLean J. (1989) Zool. Scr. **18**: 49-66 [58-60].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [170].

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Hirtopelta McLean, 1989

Species	Distribution
H. hirta McLean, 1989	East Pacific Rise: 13-21°N
H. tufari Beck, 2002	East Pacific Rise: 21°S

Size: Shell length up to 13 mm.

Color: Olive-brown.

Morphology: Shells more or less depressed, ear-shaped, sculptured by raised, scale-like projections arranged along growth lines. Shells usually covered by rust-like crusts. Gill huge in relation to body size. Stomach and intestine very narrow, intestine forming only a very short simple loop.

Biology: Genus endemic to vents. Gill and intestine morphology indicate that *Hirtopelta* uses the gill for chemosynthetic purposes. Larval development lecithotrophic with planktonic dispersal stage.

1: All specimens *H. hirta*; D. Brabant © MNHN and P. Briand © Ifremer.

References:

Beck L.A. (2002) Arch. Moll. **130** (1-2): 249-257.
Fretter V. (1989) J. Zool. Lond. **218**: 123-169.
McLean L. (1989) Zool. Scr. **18**: 49-66 [60-62].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [35].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [169].

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Lirapex Warén & Bouchet, 1989

Species	Distribution
L. costellata Warén & Bouchet, 2001	Mid-Atlantic Ridge: Lucky Strike, Snake Pit
L. granularis Warén & Bouchet, 1989	East Pacific Rise: 9-21°N
L. humata Warén & Bouchet, 1989	East Pacific Rise: 21°N

Size: Shell height up to 3.4 mm.

Morphology: Shells very small to small, valvatoid, regularly coiled, about three whorls, rather sturdy, aperture almost circular, umbilicus narrow to wide, suture deep, last part of body whorl often detached. Protoconch with sculpture of strong spiral ridges, teleoconch with axial ribs, variable from species to species. Shell whitish to brownish with more or less thick periostracum; specimens are often encrusted with mineral deposits. Operculum multispiral with central nucleus, completely closing the aperture. Head with simple tentacles and a snout of even width.

Biology: On soft bottom and among *Bathymodiolus*. Genus endemic to vents. Stomach contains amorphous organic material but rarely sponge spicules, crustacean remains. Larval development lecithotrophic with planktonic dispersal stage.

1 top: Apertural view of two specimens of *L. costatus*; by A. Warén; bottom: Same species; by P. Briand.

2: Larvae; by courtesy of L. Mullineaux.

References:

Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [84-86].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [170-171].

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Nodopelta McLean, 1989 "tapersnout limpets"

Species	Distribution
N. heminoda McLean, 1989	East Pacific Rise: 13°N, 21°N
N. rigneae Warén & Bouchet, 2001	East Pacific Rise: 13°N
N. subnoda McLean, 1989	East Pacific Rise: 13°N

Size: Shell length up to 20 mm.

Color: Beige to olive-brown.

Morphology: Shells limpet-shaped, depressed, apex close to posterior margin but not overhanging it. Sculpture finely clathrate with scattered imbricate nodes. Periostracum thick. No eyes, no operculum. Mantle margin with transverse ridges aligned perpendicular to mantle edge.

Biology: Closely associated with black smokers, recovered from aggregations of *Alvinella*. Genus endemic to East Pacific Rise vents. Larval development lecithotrophic with planktonic dispersal stage.

1 top: *N. heminoda*; middle: *N. subnoda*; bottom: *N. rigneae*. All with exterior, interior and lateral view. Top and middle row by R. von Cosel & A. Le Goff; bottom row by A. Warén.

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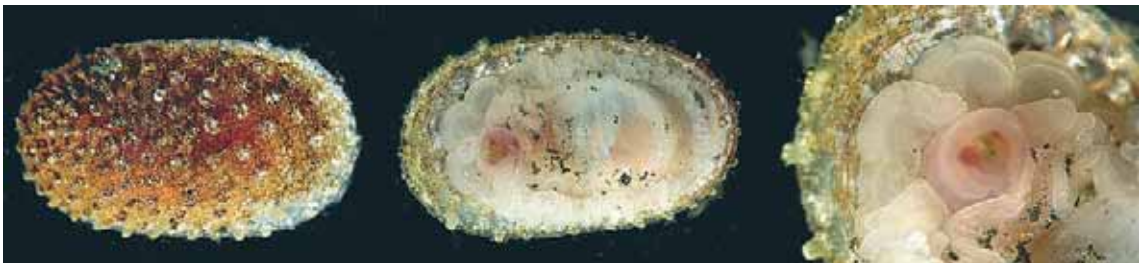
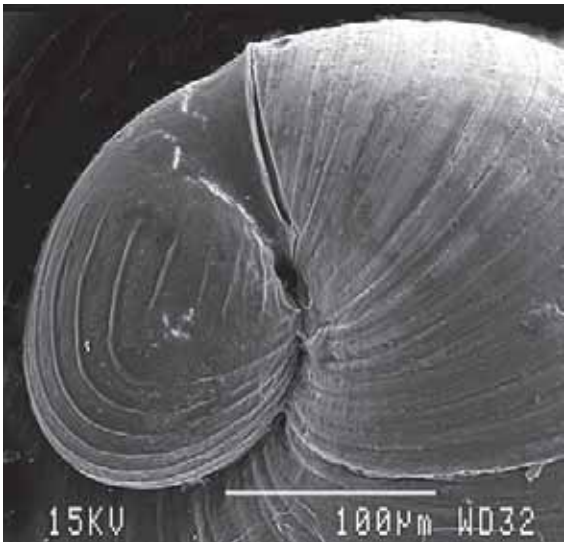


2: *Nodopelta* sp., exterior, interior and close up of interior view; by S. Hourdez © Roscoff.

3: *N. subnoda* top middle and right; bottom left and middle; bottom right is *N. heminoda*; by P. Briand © Ifremer.



4: Larva (SEM); by courtesy of L. Mullineaux.

5: In situ *Nodopelta* sp. among alvinellid worms; East Pacific Rise: 13°N, Phare cruise © Ifremer.

References:

Fretter V. (1989) J. Zool. Lond. **218**: 123-169.
McLean J. (1989) Zool. Scr. **18**: 49-66 [53-56].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [168-169].

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Peltospira McLean, 1989 "tapersnout limpets"

Species	Distribution
P. delicata McLean, 1989	East Pacific Rise: 9-13°N
P. lamellifera Warén & Bouchet, 1989	East Pacific Rise: 13°N
P. operculata McLean, 1989	East Pacific Rise: 9-21°N, 17°S
P. smaragdina Warén & Bouchet, 2001	Mid Atlantic Ridge: 15-38°N

Size: Shell length up to 12 mm.

Color: Olive-brown.

Morphology: Shells depressed, ear-shaped, with a distinctly coiled initial whorl; sculptured by numerous concentric lamellae (species differ in sculpture). Strong periostracum. Operculum small, not closing the shell (*P. operculata*) or even absent (*P. delicata*). Eyes absent. Epipodium bearing club-shaped processes of irregular size, along opercular lobe.

Biology: Specimens have been collected from washings of *Alvinella* and appear to be closely associated with active smokers. Genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage.

1 top: Four specimens of *P. smaragdina*; by A. Le Goff © MNHN; middle: Five specimens of *P. operculata*; from these the upper three specimens by A. Le Goff © MNHN and the lower two specimens with lateral and exterior view; by P. Briand © Ifremer; bottom: Three specimens of *P. delicata*, interior, lateral and exterior; by A. Le Goff © MNHN.

References:

Fretter V. (1989) J. Zool. Lond. **218**: 123-169.
McLean J. (1989) Zool. Scr. **18**: 49-66 [51-53].
Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [84-85].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [165-168].

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Rhynchopelta concentrica McLean, 1989 "tapersnout limpet"

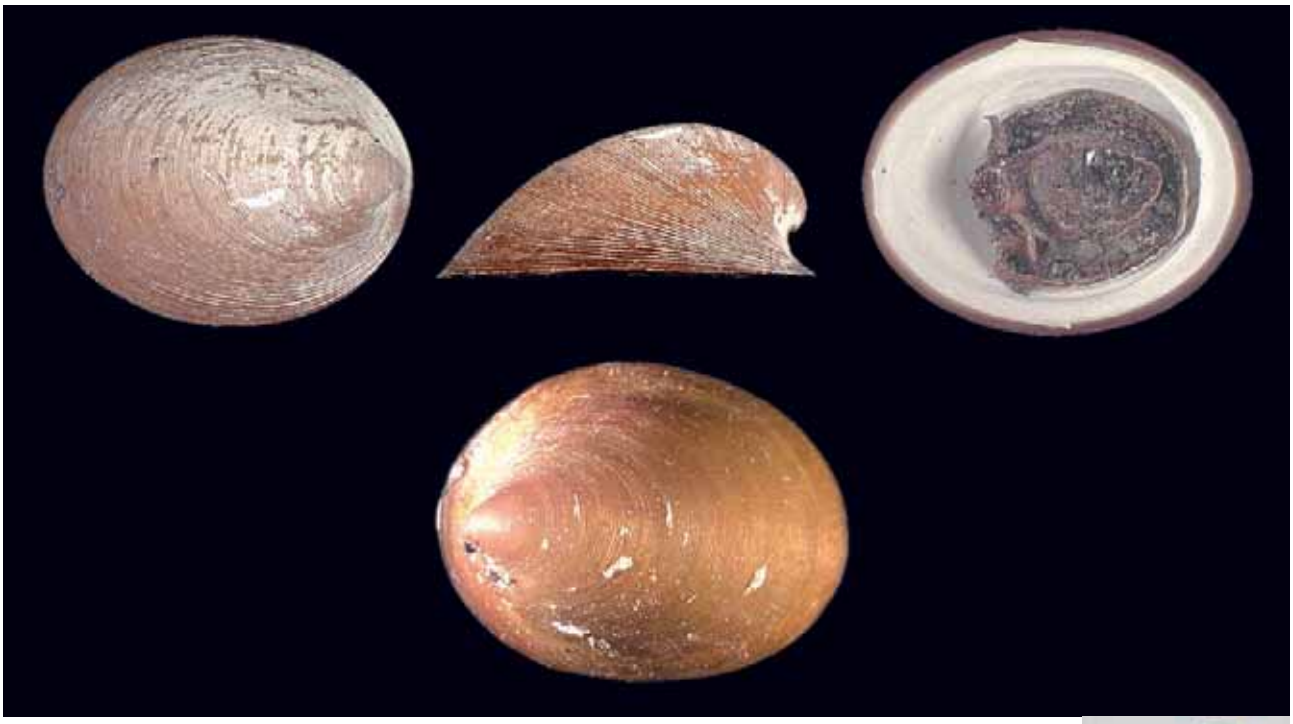
Size: Shell length up to 13 mm.

Color: Yellowish-brownish.

Morphology: Shell of limpet form, apex projecting close to the posterior margin. Sculpture of fine concentric ridges and radial striae. Periostracum thin. No operculum. Epipodium and mantle edge simple, without modification.

Biology: Associated with the tubes of *Riftia*. Genus endemic to vents. Larval development lecithotrophic with planktonic dispersal stage.

Distribution: East Pacific Rise: 21-17°N.



1 top: Exterior, lateral and interior view; by R. von Cosel & A. Le Goff; bottom: Exterior, lateral and interior view; by P. Briand.

2: Larva; by courtesy of L. Mullineaux.

References:

Fretter V. (1989) J. Zool. Lond. **218**: 123-169.
McLean J. (1989) Zool. Scr. **18**: 49-66 [57-58].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [170].

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Mollusca, Gastropoda, Neomphalina, Peltospiroidea, Peltospiridae

"scaly foot gastropod"

Size: Shell length up to 50 mm.

Morphology: Shell globular, ear-shaped, distinctly coiled; sculptured by numerous spiral ribs and growth lines. Periostracum thick, dark olive brown. Operculum absent in adult. Cephalic tentacles thick, conical without eyes. Epipodium strongly reduced, consisting of a series of inconspicuous tubercles on the side of the foot above the scales. Operculum modified into several hundred horizontally aligned scales, arranged in a roof tile fashion along the sides of the foot. Scales covered by thick layers of quite pure pyrite and greigite (iron sulphides) deposited in a very uniform way, indicating active participation by the snail in the process.

Remark: This genus and species is still not formally named, but its conspicuous morphology and interesting symbiosis makes it desirable to include this novelty.

Biology: The scaly-foot gastropod harbours thiotrophic γ-proteobacteria in an enormously enlarged oesophageal gland. It is a sedentary organism firmly attached to rocks at the base of black smoker chimneys. Genus endemic to vents. Sexes separate, sperm transfer by spermatophores. Development lecithotrophic, presumably with a planktonic dispersal stage.

Distribution: Indian Ocean: Rodriguez Triple Junction.

1 top from left to right: Complete specimen, lateral, ventral view, and front view of head-foot (shell and mantle removed); bottom from left to right: Shell, front, apical, and basal view. Maximum diameter of complete specimen 50 mm; by A. Warén.

References:

Warén A., Bengtsson S., Goffredi S.K. & C. Van Dover (2003) Science **302**: 1007.
Goffredi S.K., Warén A., Orphan V.J., Van Dover C.L. & R.C. Vrijenhoek (2004) Appl. Environ. Microbiol. **70**(5): 3082-3090.

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Olgasolaris Beck, 1992

Species	Distribution
O. tollmanni Beck, 1992	Manus Back-Arc Basin
Olgasolaris sp.	North Fiji and Lau Back-Arc Basins

Size: Shell diameter up to 13 mm.

Color: Animal pinkish-reddish when alive.

Morphology: Shells almost circular, of limpet shape, depressed, with subcentral apex; sculptured by very fine, radiating, beaded ribs; narrow shelf-like septum on the posterior inner side of shell. Small, vestigial operculum. Animal with large oral lobe, penis near right cephalic tentacle. Eyes rudimentary; similar size in veliger larva and adult.

Biology: Genus endemic to vents. Feeds by grazing bacterial mats from surfaces of sulphide chimneys and of shells of bivalves and gastropods. The reddish colour of live animals is probably caused by hemoglobin. Larval development with planktotrophic larvae. Egg capsules, 1 mm diameter, deposited on shells of other molluscs, often in large numbers on *Ifremeria*.

1: *O. tollmanni*; top left, bottom right, bottom left: exterior view, top right: Interior view; middle lateral view; by R. von Cosel.

Reference:

Beck L. (1992) Ann. Nat.hist. Mus. Wien B **93**: 259-275.

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Shinkailepas Okutani, Saito & Hashimoto, 1989

Species	Distribution
S. briandi Warén & Bouchet, 2001	Mid-Atlantic Ridge: Lucky Strike, Menez Gwen, Logatchev
S. kaikatensis Okutani, Saito & Hashimoto, 1989	Kaikata Seamount
S. mojinensis Sasaki, Okutani & Fujikura, 2003	Ogasawara Ridge
S. tufari Beck, 1992	Manus Back-Arc Basin
Shinkailepas sp.	North Fiji Back-Arc Basin
Further undescribed species	Mariana Back-Arc Basin, Indian Ocean, East Pacific Rise:

Size: Shell length up to 11 mm.

Color: Animal bright red infreshly dead and living specimens.

Morphology: Shells symmetrical, of limpet shape, depressed, with posteriorly inclined apex; sculptured by radiating ribs; shelf-like septum on the posterior inner side of shell. Small, vestigial operculum. Animal with large oral lobe, penis near right cephalic tentacle; very small eyes present in larvae and at least some species.

Biology: Genus endemic to vents. The reddish colour of fresh animals is probably caused by hemoglobin. Development with planktotrophic larvae. Egg capsules common on shells and other hard surfaces.

1: *S. briandi*: exterior, interior and lateral views; by R. von Cosel & A. Le Goff.

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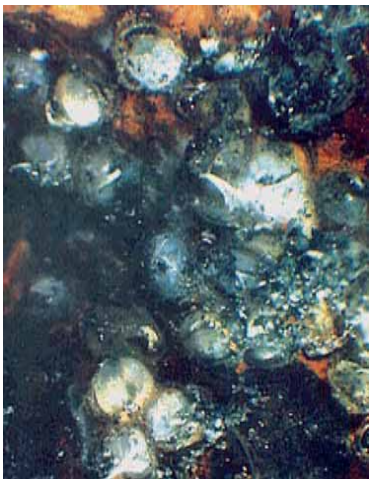
2: *S. briandi*: exterior, interior view; by P. Briand.



3: *S. briandi*: eggs; by P. Briand.

4: *S. briandi*: in situ; by P. Briand.

References:

Beck L.A. (1992) Ann. Nat.hist. Mus. Wien B **93**: 259-275.

Okutani T., Saito H. & J. Hashimoto (1989) Venus **48**: 223-230 [224].

Sasaki T., Okutani T. & K. Fujikura (2003) Veliger **46**(3): 189-210 [201].

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [174-177].

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Eosipho Thiele, 1929

Species	Distribution
E. auzendei Warén & Bouchet, 2001	East Pacific Rise: 17-23°S; Pacific-Antarctic Ridge: 31-38°S
E. desbruyeresi Okutani & Ohta, 1993	Mariana, North Fiji and Lau Basins
E. desbruyeresi nipponensis Okutani & Fujiwara, 2000	Okinawa Trough, Ogasawara

Size: Shell length up to 70 mm.

Color: Chestnut brown to black.

Morphology: Large whelks with solid, smooth shell. Spire always truncated (early whorls dissolved) in subadults and adults. Thick corneous operculum smaller than aperture.

Biology: A small radiation of buccinids living at vents; provisionally placed in the genus *Eosipho*, a genus known from sunken drift wood and normal bathyal environments. A related species lives at Caribbean seeps. Buccinidae are carnivorous or scavengers and *E. desbruyeresi* has been collected in quantity in baited traps.

1: *E. desbruyeresi*; top left to right: Abapertural, lateral and apertural view; bottom: Lateral views; by R. von Cosel & P. Lozouet.

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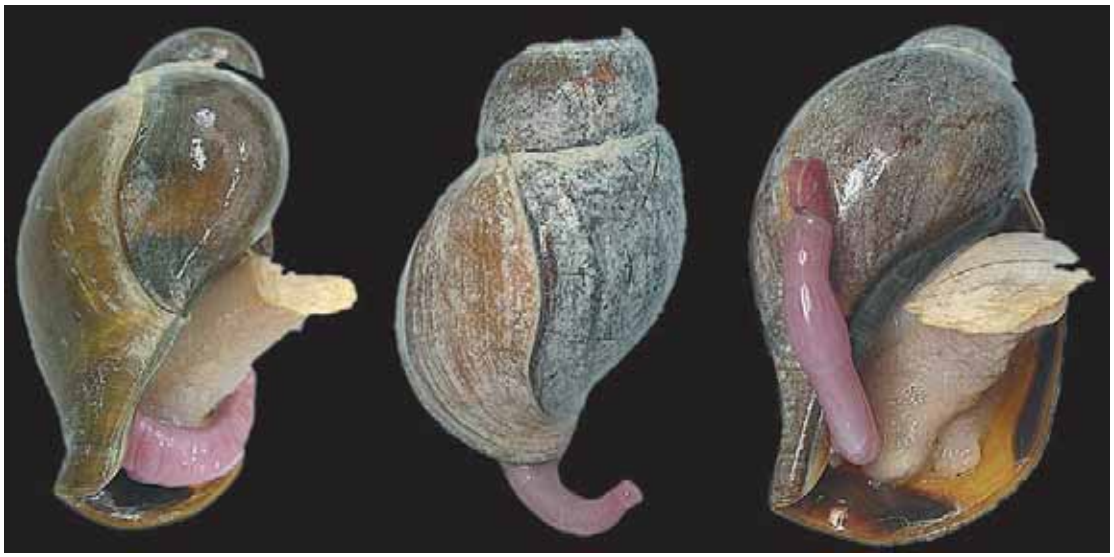
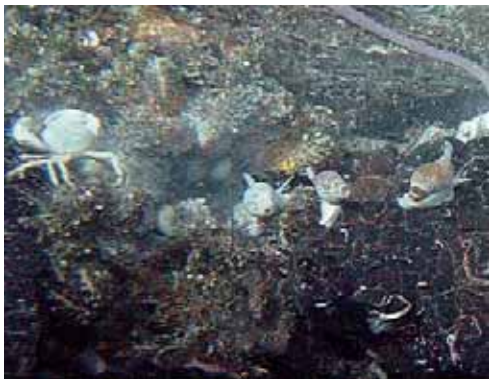


2: *E. auzendei*, in vivo specimens; by R. von Cosel & P. Lozouet.



3: *E. auzendei* in situ, with bythograeid crab, chiridotid holothurian and serpulid worm *Laminatubus alvini* from southern East Pacific Rise, cruise Biospeedo © Ifremer.

4: *E. desbruyeresi* in situ, among mytilid *Bathymodiolus brevior* from Lau Back-Arc Basin, cruise TUIM07; by courtesy of C.R. Fisher.

References:

Okutani T. & S. Ohta (1993) Venus **52**: 217-221.

Okutani T. & Y. Fujiwara (2000) Venus **59**: 123-128 [125-126].

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [190-191].

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Speculator cariosus Warén & Bouchet, 2001

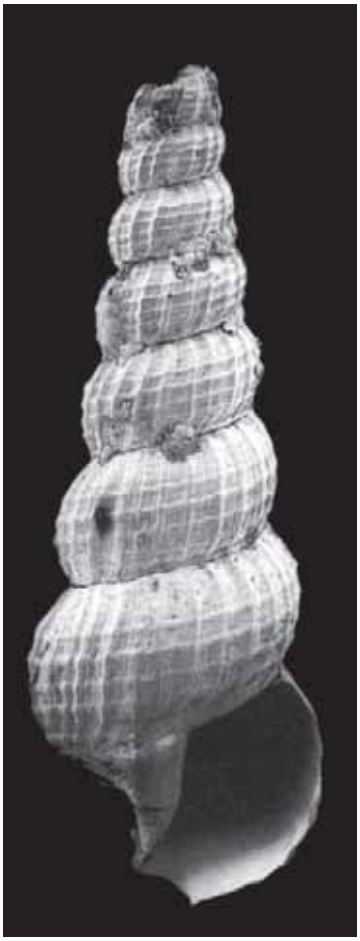
Size: Shell height up to 8.3 mm.

Color: Brownish yellow.

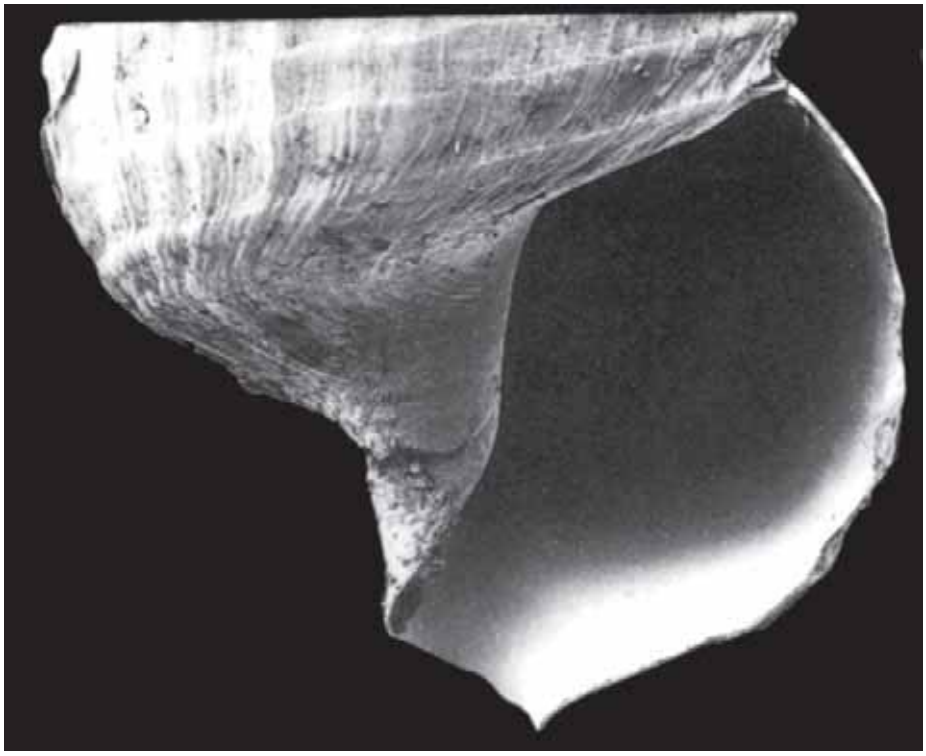
Morphology: Shell tall and very slender, rather fragile, with high spire and small, rounded aperture with obliquely drawn-out siphonal canal. Whorls distinctly convex. Surface with four strong spiral cords and two more on the body whorl and with somewhat variable axial ribs, about 30 on the body whorl, resulting in a reticulate sculpture. Uppermost whorls eroded. Operculum thin, paucispiral, with indistinct coiling and strongly excentric nucleus.

Biology: The only known specimen was collected together with tubeworms *Ridgeia piscesae*, but nothing is known about its diet.

Distribution: Northern Pacific, known only from Explorer Ridge: Magic Mountain (Steve 4 vent).



1: Apertural view; after Warén & Bouchet (2001).



2: Enlargement of aperture; after Warén & Bouchet (2001).

Reference:

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231.

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Laeviphitus desbruyeresi WARÉN & BOUCHET, 2001

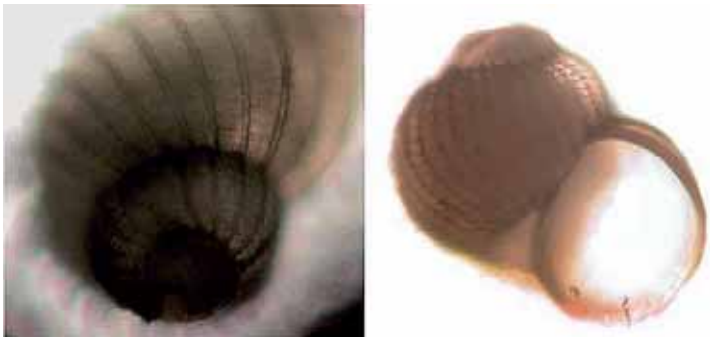
Size: Shell height up to 1.8 mm.

Morphology: Shell very small, not especially fragile, about four whorls, with shallow suture, narrow umbilical crevice and anteriorly bluntly rounded and posteriorly slightly pointed aperture, smooth teleoconch and distinctly demarcated and cancellate protoconch. Shell surface usually with strong ferrugineous deposits. Operculum thin, yellowish brownish, paucispiral.

Biology: Among *Bathymodiolus* and in sediment. Genus known from vents and driftwood (unpubl.). Development with planktotrophic larvae.

Distribution: Mid-Atlantic Ridge: Menez Gwen to Rainbow. Genus also known from Japan (*Laeviphitus japonicus* OKUTANI, FUJIKURA & SASAKI, 1993) and the Marianas (unpubl.). Larvae common at the East Pacific Rise: 13°N, but no juvenile or adult specimens have been found.

1: The same specimen with and without ferrugineous layer; scale bar 0.5 mm; by A. Warén.



2: Different views of larvae; by L. Mullineaux.

References:

OKUTANI T. FUJIKURA K. & T. SASAKI (1993) Bull. Natn. Sci. Mus., Tokyo A **19**(4): 123-143.
WARÉN A. & P. BOUCHET (2001) Veliger **44**(2): 116-231 [182].

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Alviniconcha hessleri Okutani & Ohta, 1988

Size: Shell height up to 85 mm.

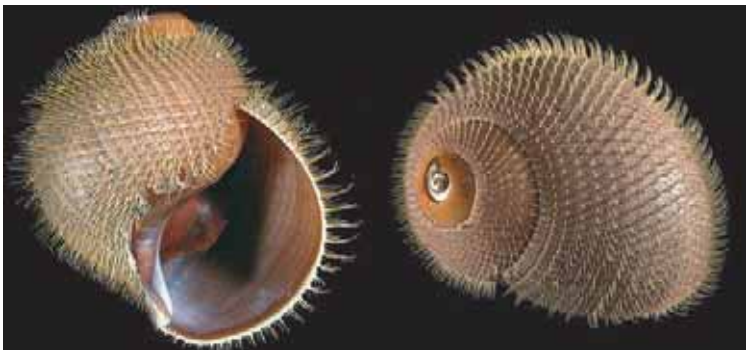
Color: Yellowish.

Morphology: Shell globose, rather elastic, spectacularly ornamented with regularly spirally arranged periostracal hairs. Aperture with a shallow sinus in front. Operculum horny and ovo-quadrate.

Biology: Genus endemic in vents. Usually in stacks around vent openings where they are exposed to warm (up to 13°C), sulphide-rich (up to 750 µM) water. Scattered specimens live on side of chimneys and attain a very large size. The gill is hypertrophied and specialized gill cells contain endosymbiotic chemoautotrophic bacteria of the sulphur cycle. Reduced digestive tract as compared to related species of the same family.

Distribution: A single morphospecies in the Western Pacific: Mariana, North-Fiji and Lau Back-Arc Basins; Indian Ocean: Rodriguez Triple Junction, Kairei hydrothermal field. Nevertheless, *A. hessleri* from the type location is genetically different from the three *Alviniconcha* populations collected at other places.

1: Apertural view; by P. Briand © Ifremer.



2: Dorsal and ventral view; by P. Briand © Ifremer.

3: In situ specimen in the Lau Back-Arc Basin; Biolau cruise © Ifremer.

4: In situ population at Lau Back-Arc Basin; Biolau cruise © Ifremer.

References:

Denis F., Jollivet D. & D. Moraga (1993) Biochem. Syst. Ecol. **21**: 431-440.
Endow K. & S. Ohta (1989) Bull. Jap. Soc. Microb. Ecol. **3**: 73-82.
Healy J. (1992) Bull. Mus. Natl. Hist. Nat. **14**: 273-291.
Kojima S., Fujikura K., Okutani T. & J. Hashimoto (2003) Venus **63**: 65-68.
Kojima S., Ohta S., Fujiwara Y. & J. Hashimoto (1999) JAMSTEC J. Deep-Sea Res. **14**: 501-506.
Okutani T., Hashimoto J. & T. Sasaki (2004) Venus **63**: 1-11.
Okutani T. & S. Ohta (1988) Venus **47**: 1-9.
Stein J.L., Cary S.C.,Hessler R.R., Ohta S., Vetter R.D., Childress J.J. & H. Felbeck (1988) Biol. Bull. **174**: 373-378.
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90.

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Desbruyeresia Warén & Bouchet, 1993

Species	Distribution
D. cancellata Warén & Bouchet, 1993	North Fiji and Lau Back-Arc Basins
D. marianaensis (Okutani & Fujikura, 1990)	Mariana Back-Arc Basin
D. marisindica Okutani, Hashimoto & Sasaki, 2004	Central Indian Ridge
D. melanioides Warén & Bouchet, 1993	Manus and Lau Back-Arc Basins
D. spinosa Warén & Bouchet, 1993	North Fiji Back-Arc Basin
D. sp. aff. *spinosa*	Mariana Back-Arc Basin

Size: Shell height up to 10-12 mm.

Morphology: Shells regularly coiled, distinctly slender, with high spire and small, rounded aperture. Sculpture consisting of axial ribs, spiral cords, knobs and occasionally short spines. Tip often corroded, shell often encrusted. Species differ in characters of the sculpture. Eyes reduced or absent. Right pallial tentacle absent.

Biology: Genus endemic in vents; detritus feeders; development unknown.

1 top row left: *D. spinosa*; middle: *D. melanoides*; right: *D. cancellata,* holotype coated for SEM; by R. von Cosel & A. Le Goff; bottom row left: *D. spinosa*; middle and right: *D. provanna*; by P. Briand.

References:

Okutani T. & K. Fujikura (1990) Venus **49**: 83-91.
Okutani T., Hashimoto J. & T. Sasaki (2004) Venus **63**: 1-11.
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [71-73].

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Mollusca, Gastropoda, Caenogastropoda, Loxonematoidea, Provannidae

Ifremeria nautilei Bouchet & Warén, 1991

Synonym: *Olgaconcha tufari* Beck, 1991.

Size: Up to 95 mm.

Color: Brown (juvenile) to black (adult).

Morphology: Shell with about two whorls, umbilicus, nearly oval aperture, and a conspicuous subsutural ramp; periostracum thickened, faintly glossy, dissolved at the apex. While the shell is growing at the aperture, the apex dissolves. Front and sides of foot conspicuously light blue in living specimens.

Biology: Genus with a single species endemic in vents, usually in massive heaps at the edge of *Alviniconcha* stacks. As in *Alviniconcha*, the gill and circulatory system are hypertrophied and the alimentary system is unexpectedly small. Two types of bacterial symbionts are present in the gills, one dominant sulphide-oxidizing bacteria and one in lower abundance, likely methane-oxidizing. Different commensal polychaetes were found inside the pallial cavity (scale worms) and the umbilicus (*Amphisamytha* cf. *galapagensis*). The female broods the larvae in a brood chamber in the foot (A. Warén, unpublished). Development probably lecithotrophic.

Distribution: North Fiji, Lau, Manus Back-Arc Basins.

1: Adult specimens, apertural and apical view; juvenile specimens, apertural view; by P. Maestrati.

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2 top: Living specimens in situ, inhabited by limpets *Olgasolaris* sp.; bottom: Left by P. Briand © Ifremer; right by Biolau cruise © Ifremer.

References:

Beck L.A. (1991) Ann. Nat.hist. Mus. Wien **92B**: 277-287.

Borowski C., Giere O., Krieger J., Amann R. & N. Dubilier (2002) Cah. Biol. Mar. **43**: 321-324.

Bouchet P. & A. Warén (1991) C. R. Acad. Sci. Paris, Sér. III **312**: 495-501.

Desbruyères D., Alayse-Danet A.-M. & S. Ohta (1994) Mar. Geol. **116**: 227-242.

Galchenko V.F., Pimenov N.V., Lein A.Y., Galkin S.V., Miller Y.M. & M.V. Ivanov (1992) Dokl. Biol. Sci. **323**: 125-129.

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [64-71].

Windoffer R. & O. Giere (1997) Biol. Bull. **193**: 381-392.

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Provanna Dall, 1918

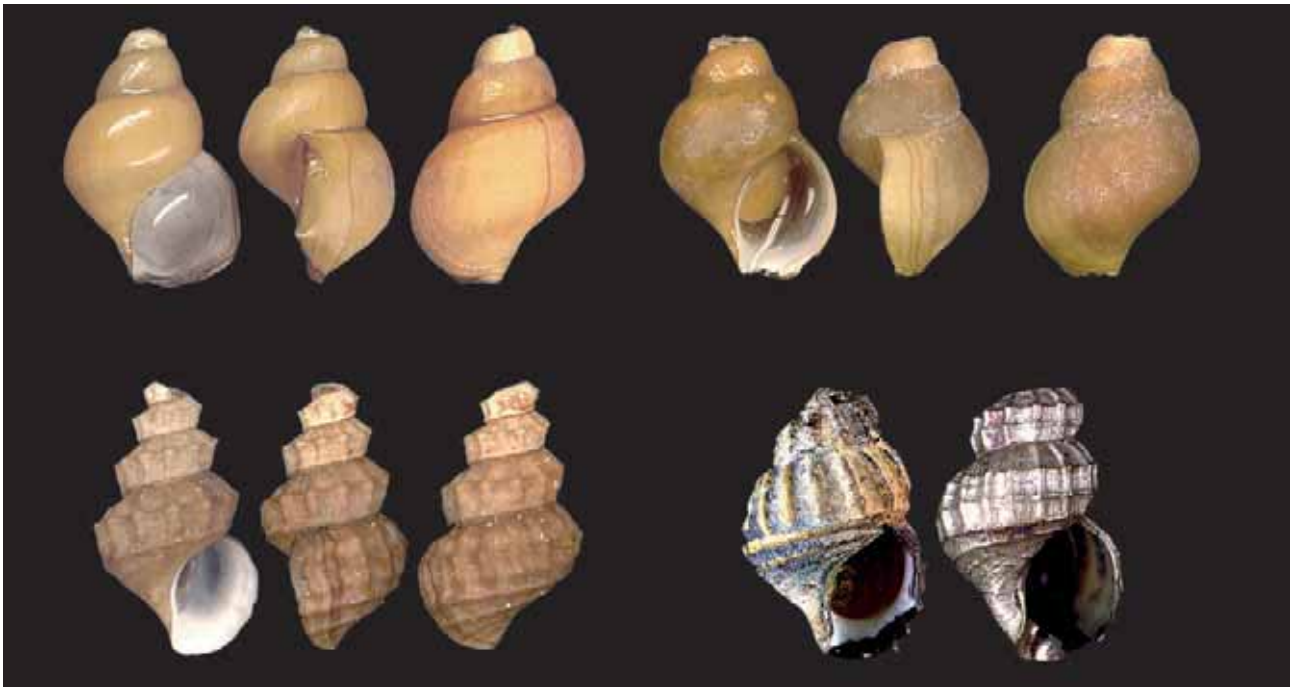
Species	Distribution
P. buccinoides Warén & Bouchet, 1993	North Fiji and Lau Back-Arc Basins
P. glabra Okutani, Tsuchida & Fujikura, 1992	Sagami Bay, Okinawa Basin
P. ios Warén & Bouchet, 1986	Galapagos, East Pacific Rise: 13-21°N, 17°S
P. laevis Warén & Ponder, 1991	Guaymas Basin
P. muricata Warén & Bouchet, 1986	North Fiji and Lau Back-Arc Basin, Galapagos Spreading Center, East Pacific Rise: 21°N
P. nassariaeformis Okutani, 1990	Mariana and Manus Back-Arc Basins
P. segonzaci Warén & Ponder, 1991	Lau Back-Arc Basin
P. variabilis Warén & Bouchet, 1986	Juan de Fuca Ridge, Oregon Margin

Size: Shell height up to 10-12 mm.

Color: Olive-brown to dark brown or greenish, often covered by thick mineral deposits.

Morphology: Shells regularly coiled, moderately slender, with rather high spire and rounded aperture. Surface smooth or with sculpture consisting of axial ribs and spiral cords. Species differ in characters of the sculpture. Tip often corroded, shells often encrusted. Eyes reduced or absent. Right pallial tentacle present.

Biology: Genus known from vents, seeps and sunken drift wood (only the vent species are listed herein). Detritus feeders; development without planktotrophic larvae in species with known protoconchs. One species from seeps has adelphophagy and hatches in the crawling stage (A. Warén, unpublished).



1 top left: *P. laevis*; top right: *P. variabilis*; bottom left: *P. ios*; bottom right: *P. buccinoides*; by P. Briand.

References:

Okutani T. & K. Fujikura (1990) Venus **49**: 83-91.
Okutani T., Tsuchida S. & K. Fujukura (1992) Venus **51**: 137-148.
Warén A. & P. Bouchet (1986) Zool. Scr. **15**: 157-164.
Warén A. & P. Bouchet (1989) Zool. Scr. **18**: 67-102 [94-95].
Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [74-76].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [178-179].
Warén A. & W.F. Ponder (1991) Zool. Scr. **20**: 27-56.

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Alvania cf. *stenolopha* Bouchet & Warén, 1993

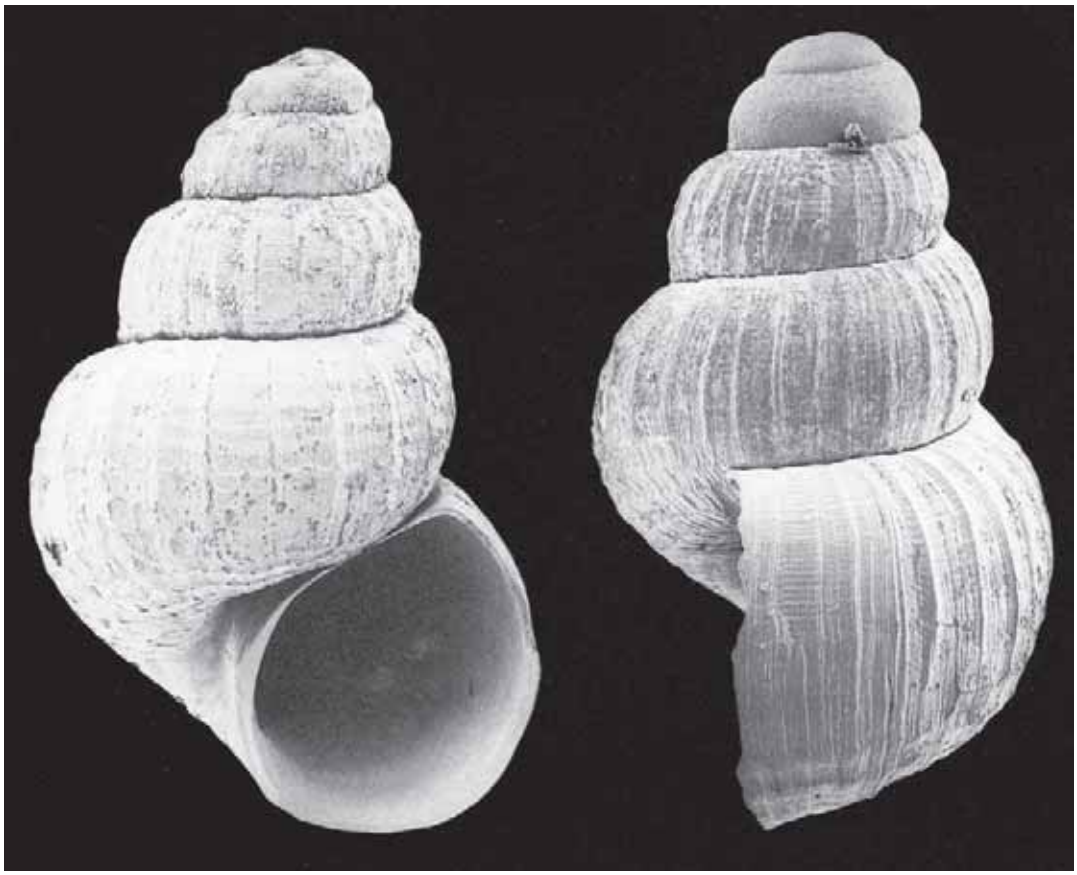
Size: Shell height up to 2.6 mm.

Morphology: Shell small, conical, thin and fragile, with blunt spire and large aperture, outer lip not thickened. Whorls distinctly and evenly convex, suture well-marked. Surface with very fine but distinct spiral lines, 4-8 stronger spiral cords at and below the periphery and distinct, evenly spaced sharp and narrow axial ribs, 20 on the last whorl, which end abruptly at the first to third spiral cord. Protoconch dome-shaped, with 1.4 whorls, diameter about 460 µm, teleoconch with 2.4 whorls.

Remark: It is not sure whether or not this species is a member of the vent fauna; the species was described from a locality about 150 km northeast of Menez Gwen.

Biology: Development lecithotrophic; each egg capsule contains a single juvenile. At vent sites encountered on sulphide rocks or at the base of black smokers, partly with Hydrozoa.

Distribution: Mid-Atlantic Ridge: Lucky Strike, Menez Gwen and surroundings.



1 left: Specimen 1, 2.6 mm, apertural view; right: Specimen 2, 2.3 mm; Menez Gwen; after Warén & Bouchet (2001).

References:

Bouchet P. & A. Warén (1993) Boll. Malacol. Suppl. **3**: 579-840.
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231.

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Neusas marshalli Sykes, 1925

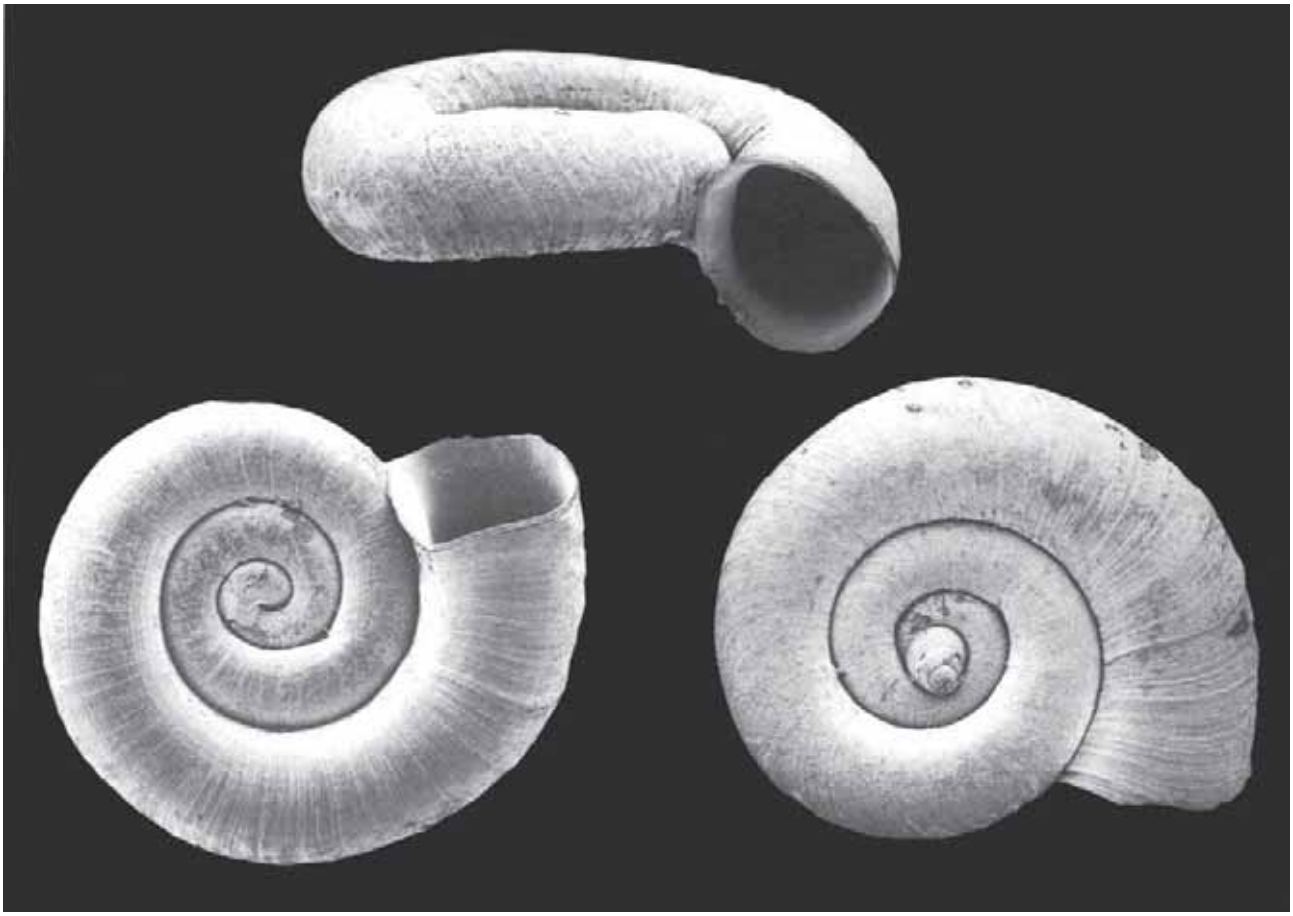
Size: Shell diameter up to 2.06 mm.

Morphology: Shell planispiral, resembling a planorbid, with rounded and almost smooth whorls with a deep suture. Protoconch tall-spired and obliquely inserted, with slightly more than two whorls, smooth. Teleoconch with about three slightly irregularly coiled whorls. Operculum corneous, multispiral, round with central nucleus.

Remarks: The species was also collected from a non-hydrothermal locality off Portugal, 39°42'N, 09°43'W, 1092-1993 m (type locality). Two other species of the genus are known; they are confined to non-vent localities off New Caledonia and off New Zealand.

Biology: No data. Apparently the species is not obligatorily confined to vents.

Distribution: Mid-Atlantic Ridge: Menez Gwen.



1 top: Apertural view; bottom left: Basal view; bottom right: Apical view (note the inclined protoconch); from Menez Gwen; after Warén & Bouchet (2001).

Reference:

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231.

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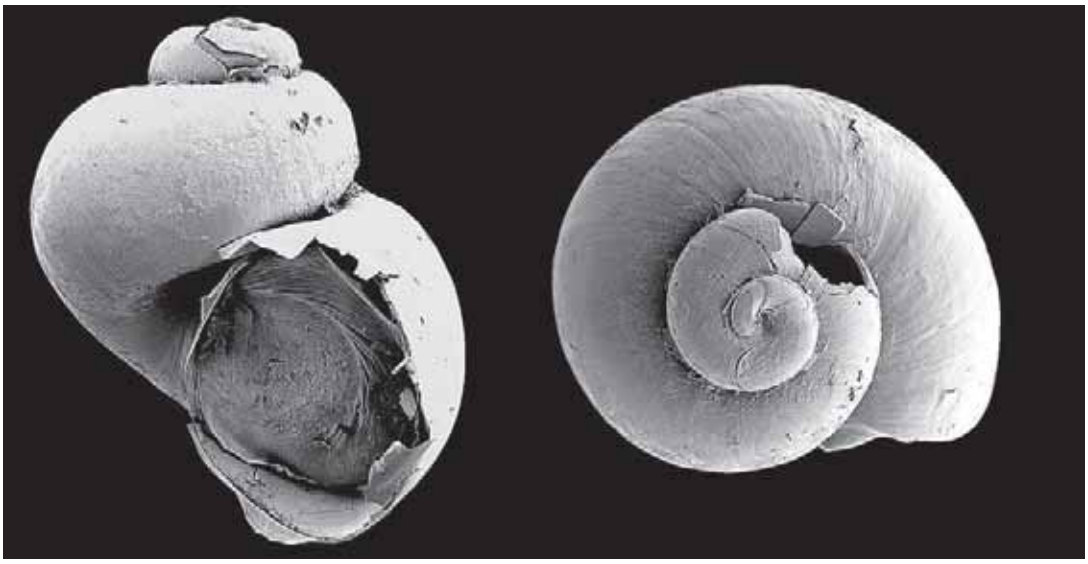
Hyalogyrina Marshall, 1988

Species	Distribution
H. globularis Warén & Bouchet, 2001	Juan de Fuca Ridge: Endeavour Segment
H. grasslei Warén & Bouchet, 1993	Guaymas Basin

Size: Maximum height ca 3.4 mm.

Morphology: Shell small, rather fragile, depressed, globular or more tall-spired, 2.5-4 whorls on the teleoconch, vitreous and fragile, with deep suture, deep umbilicus, aperture rounded. Initial part of protoconch sculptured by small, crowded pits, later smooth, teleoconch smooth. Operculum round, transparent and colorless to brown, multispiral with distinct growth lines and central nucleus. Animal with thick tentacles and almost cylindrical snout. Additional tentacles behind the normal cephalic ones of variable development, possibly changing with age. Foot large, broad and flat, rounded or truncated posteriorly and shallowly bilobed anteriorly, no propodium distinguishable.

Biology: Epifaunal grazers. Genus known from vents, seeps, whalebone and driftwood. Development unknown.



1: *H. globularis*, apertural and dorsal view of a specimen; Juan de Fuca Ridge, Endeavour Segment, Clam Bed; by A. Warén.

2: *H. globularis*, critical point dried specimen; front view of head-foot, shell and pallial skirt removed; Juan de Fuca Ridge, Endeavour Segment, Clam Bed; by A. Warén.

3: *H. umbellifera*, early protoconch; A. Warén.

References:

Warén A. & P. Bouchet (1993) Zool. Scr. **22**: 1-90 [49-52].
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [200-207].

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Lurifax vitreus Warén & Bouchet, 2001

Size: Diameter up to 2.8 mm.

Morphology: Shell small, rather fragile, depressed conical, five whorls, vitreous, with shallow suture, broad and deep umbilicus. Protoconch smooth, teleoconch with spiral striae and stronger ribs and radiating flexuous incremental lines. Surface often covered by thick crusts of rust. Operculum stiff, almost transparent, multispiral with six whorls and central nucleus. Animal with well developed eyes at the dorsal base of simple cylindrical tentacles. Foot with well-demarcated propodium, no appendages except metapodial lobes.

Biology: Epifaunal. Genus known from vents and seeps. Development unknown.

Distribution: Mid-Atlantic Ridge: Menez Gwen and Lucky Strike. Genus with three species endemic to vents and seeps. One at Lau and Fiji Back-Arc Basins. *Lurifax japonicus* from Sumisu Caldera, Southern Japan.

1 top from left to right: Apertural, apical and ventral view of the same specimen; by R. von Cosel & A. Le Goff; bottom: Three specimens by A. Warén.

2 left and right: Specimens (SEM); by A. Warén; middle: Living specimen; by P. Briand @ Ifremer.

References:

Sasaki T. & T. Okutani (2005) Venus **63**: 121-124.
Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [207-208].

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Xylodiscula analoga WARÉN & BOUCHET, 2001

Size: Diameter up to 3 mm.

Morphology: Shell small, fragile, subplanispiral, 2.5 whorls (teleconch), with rather deep suture, very wide and deep umbilicus and subradial and slightly prosocline aperture. Protoconch always corroded, teleoconch with incremental lines, otherwise smooth. Surface with a thick, yellowish-brownish periostracum. Operculum thin and transparent, round, smooth, multispiral with central nucleus.

Biology: Found among *Bathymodiolus* and on sediment. Genus known from vents, seeps and biogenic substrates. Development unknown.

Distribution: Mid-Atlantic Ridge: Menez Gwen and Lucky Strike. Another species, *Xylodiscula major* WARÉN & BOUCHET, 1993 was collected from North Fiji Back-Arc Basin.

1: Two specimens: left dorsal view, right ventral view; by A. Warén.

References:

WARÉN A. & P. BOUCHET (1993) Zool. Scr. **22**: 1-90 [35].
WARÉN A. & P. BOUCHET (2001) Veliger **44**(2): 116-231 [208, 210].

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Phymorhynchus Dall, 1908

Species	Distribution
P. carinatus Warén & Bouchet, 2001	Mid-Atlantic Ridge: 23-15°N
P. hyfifluxi Beck, 1996	North Fiji Basin
P. major Warén & Bouchet, 2001	East Pacific Rise: 13-9°N
P. moskalevi Sysoev & Kantor, 1995	Mid-Atlantic Ridge: 26-23°N
P. ovatus Warén & Bouchet, 2001	Mid-Atlantic Ridge: 37-15°N
P. starmeri Okutani & Ohta, 1993	North Fiji and Manus Back-Arc Basins; may be common in both vent and non-vent areas in upper abyssal bottom
P. wareni Sysoev & Kantor, 1995	Edison Seamount, Lihir Is, West Pacific

Size: Shell height to 72 mm.

Morphology: Shells short, obese fusiform or bucciniform. Shell surface white with strong spiral ribs (about 8-10 on penultimate whorl and some 25-30 on body whorl including base) which overlie weak growth lines. Spire roundly conical, but body whorl well inflated, occupying about 50% of shell length. Aperture wide, lunate, with crenulated outer lip corresponding to spiral ribs. Columellar lip almost straight. Siphonal canal open, not twisted. No operculum present. Head with big rhynchodaeum. Toxoglossate radula teeth hollow, needle-like in shape with basal expansion. Distal tip sharp, monocuspidate with a slit.

Biology: Often observed at the periphery of dying vents, probably predator on molluscs and scavenger. Genus known from seeps and vents as well as free-living. Larval development planktotrophic.

1 top row, left to right: Two specimens of *P. carinatus*; one specimen of *P. moskalevi*; by A. Warén (SNHM) & P. Briand (Ifremer); bottom row: Three specimens of *P. ovatus*, from Mid-Atlantic Ridge; by R. von Cosel & A. Le Goff (MNHN).

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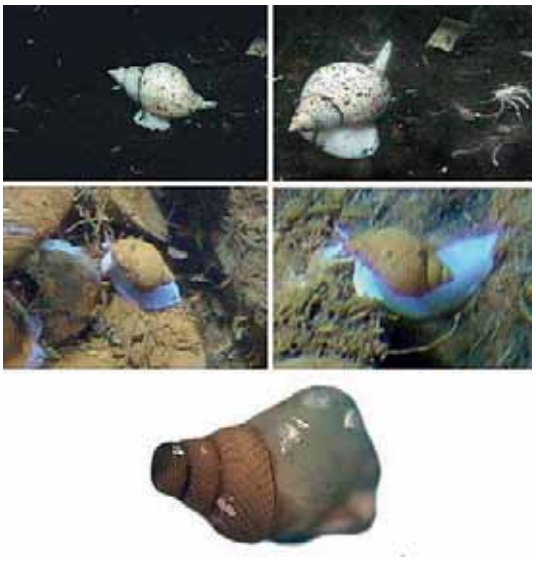
2 left to right: One specimen of *P. major* from East Pacific Rise 13°N, and two specimens of *P. starmeri* from North Fiji Back-Arc Basin; by P. Briand (Ifremer).



3: *Phymorhynchus* sp. from East Pacific Rise: 18°S, cruise Biospeedo © Ifremer; middle: *Phymorhynchus* sp. from Juan de Fuca Ridge; by K. Juniper; bottom: Larva from Juan de Fuca Ridge; by K. Juniper & L. Mullineaux.

References:

Beck L. (1996) Arch. Moll. **126**(1/2): 109-115.

Bouchet P. & A. Warén (1986) Mem. Mus. Natl. Hist. Nat., Paris, Sér. A, Zool. **133**: 457-571.

Okutani T. & S. Ohta (1993) Venus **52**(3): 217-221.

Sysoev A.V. & Y.I. Kantor (1995) Ruthenica **5**: 17-26.

Warén A. & P. Bouchet (2001) Veliger **44**(2): 116-231 [192-199].

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Dendronotus comteti VALDÈS & BOUCHET, 1998

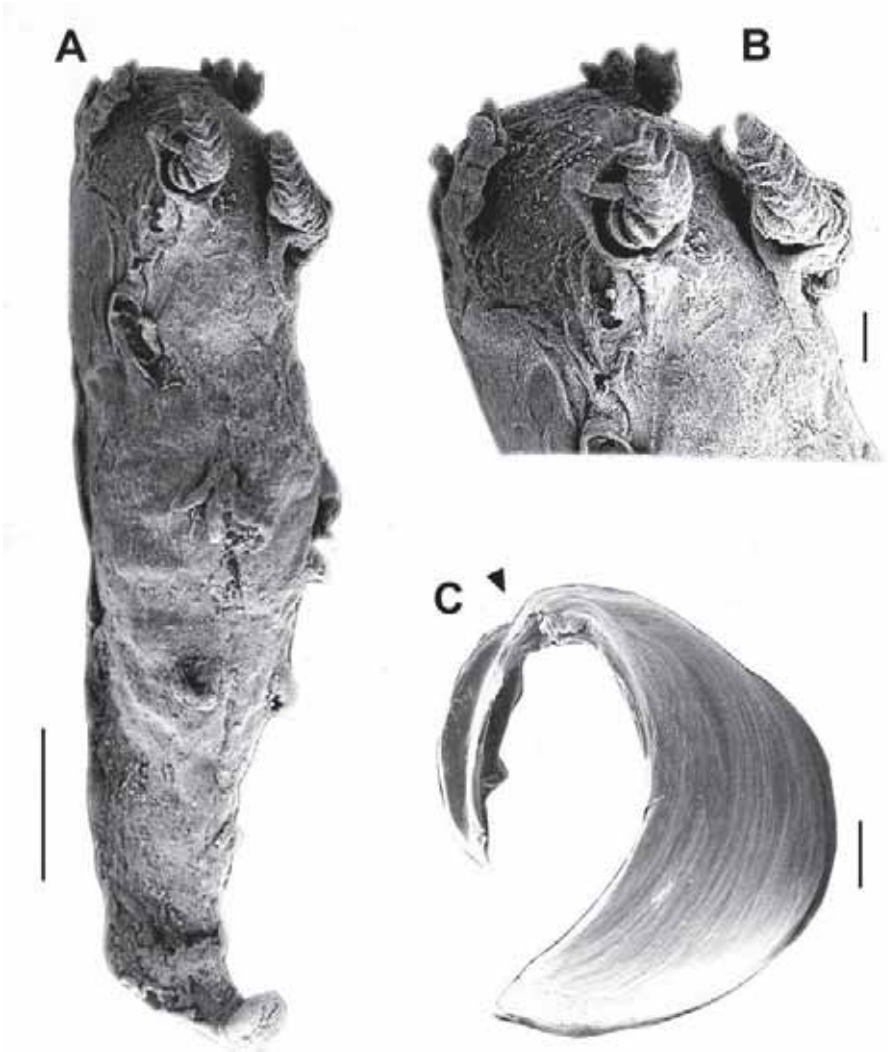
Size: Up to 5 mm.

Color: Unknown in life. Preserved specimens: uniformly pale cream background color, without traces of colored spots or lines.

Morphology: The frontal velum has four short papillae, two on each side of the body midline. Medial pair longer and always branched, but outer two only branched in the larger specimens. 2-4 pairs of cerata on each side of the dorsum. When branched, the cerata form three conical processes. Rhiniphores have 7-8 lamellae. The margin of the rhinophoral sheath has four unbranched tentacular papillae of even size.

Biology: First species of nudibranch recorded with certainty from a vent site. Living among mussel bed of *Bathymodiolus azoricus*, but probably not restricted to this environment. Its occurrence at vents can be explained on the one hand by the presence of prey such as hydrozoa (*Candelabrum phrygium*), and on the other hand by the absence of predators.

Distribution: Mid-Atlantic Ridge: Lucky Strike, Eiffel Tower.



1A: Dorsal view of the holotype (SEM); scale bar 1 mm; B: Details of the anterior region of the same specimen (SEM); scale bar 100 µm; C: Jaws of a paratype, arrow indicates masticatory border; scale bar 100 µm; cruise Diva 2, Ifremer; from VALDÈS & BOUCHET (1998).

Reference:

VALDÈS A. & P. BOUCHET (1998) Deep-Sea Res. II **45**: 319-327.